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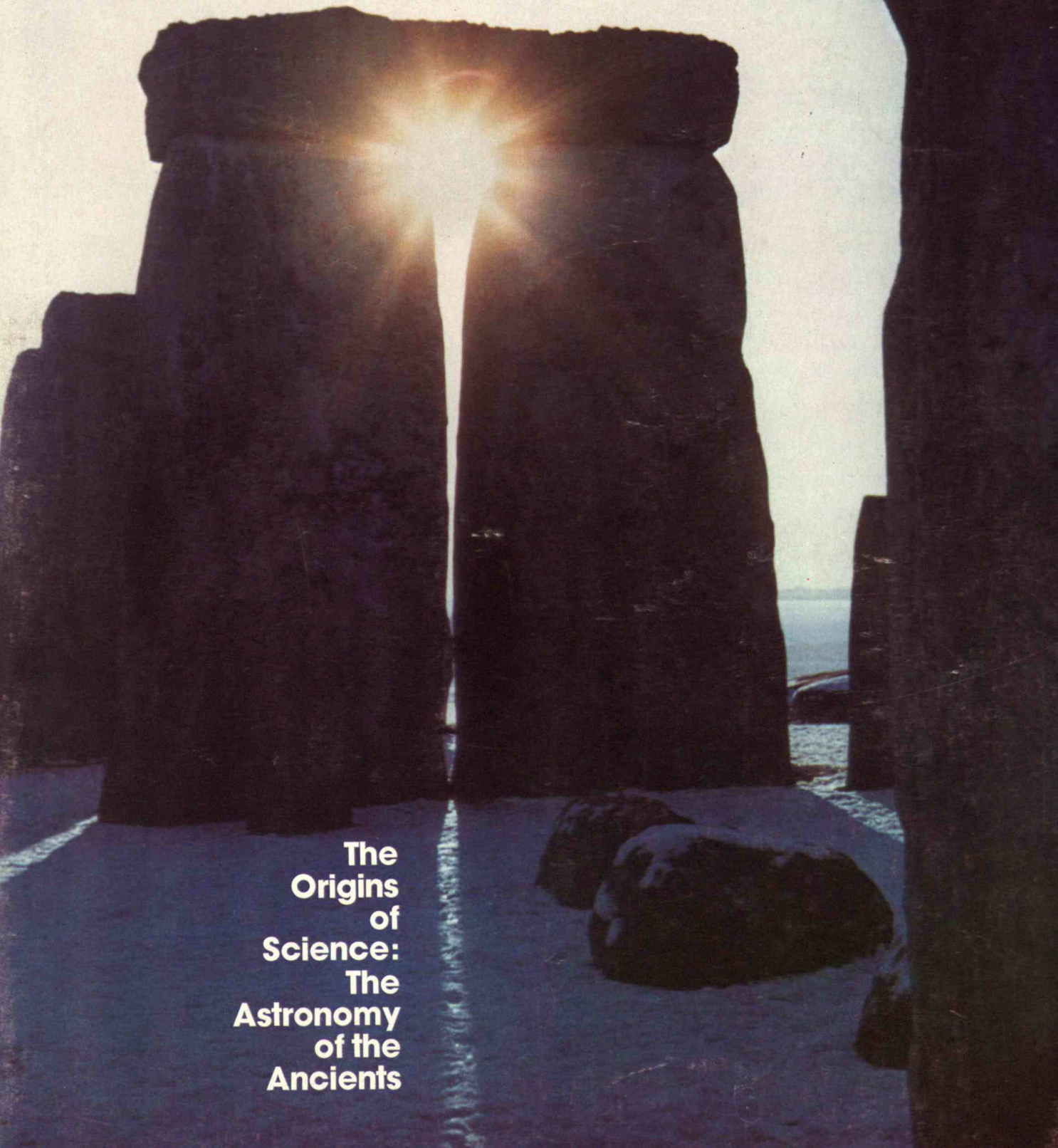
Edited at the Massachusetts Institute of Technology



The Origins of Science: The Astronomy of the Ancients

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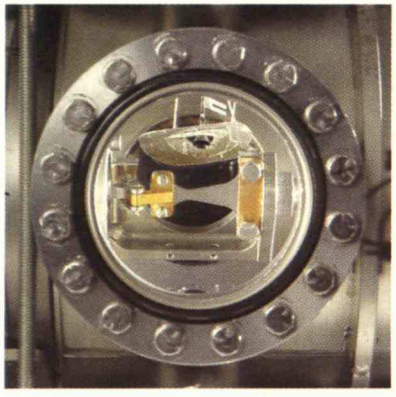
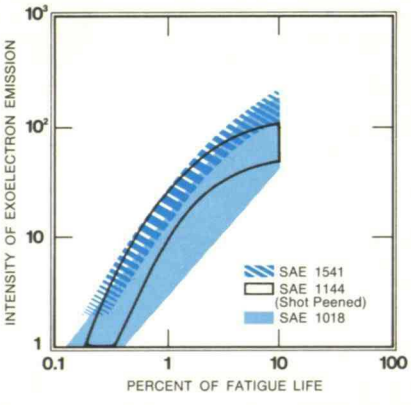
Like the human body, metal too gives early warning signs of failure. One of these, oxide cracking, appears surprisingly early.

Here at the General Motors Research Laboratories, our physicists are detecting oxide cracks by exoelectron emission measurements. As a result, they have been able to predict—after testing a sample for less than 1% of its fatigue life—when the metal will fail.

How did the basic technique evolve? In exploratory studies, ultraviolet light was used to stimulate exoelectron emission from metal samples being fatigued in a vacuum. Intensity measurements and observations in a photoelectron microscope led to these discoveries:



- Exoelectrons flow only from bare metal areas where microcracks have developed in the natural oxide coat, such as the cluster of streaks at right (magnification: 250X).
- The oxide cracks are caused by fatigue damage in the underlying metal.
- Exoelectron emission rate correlates with percent of fatigue life (the graph shows the growth of emission intensities for three types of steel fatigued under different loading conditions).



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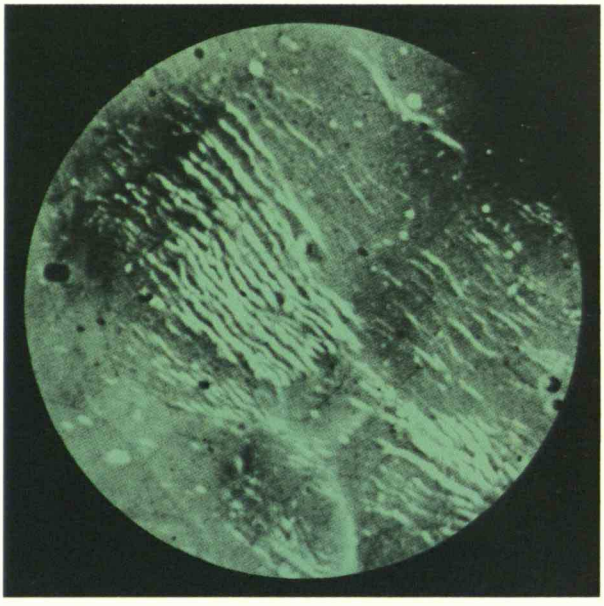
Predicting fatigue life by exoelectron emission: A scientific approach to a very old engineering problem.



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A special issue on the astronomy of the ancients.

Departments

Cover
The early-morning sun is placed between the two great megaliths of the most easterly trilithon at Stonehenge. Whether this structure in truth served to collimate the light from an event in the sky is highly uncertain, however. The megalith whose edge appears at the right of the photograph is the sole remaining stone of the north-northwest trilithon. The photograph was taken in winter by Owen Gingerich, whose article on Stonehenge appears in this issue.

The Astronomy of the Ancients

What monuments to astronomy are to be found in Boston, or in any other modern city? Few; almost none.

Yet in ancient cities, evidence of man's concern with the heavens was everywhere — in monuments, in works of worship and art, even in the alignment of streets and structures.

The observation is a classic example of Kenneth Brecher's perceptive interest in the human implications of even the most abstruse phenomena of his science. Professor Brecher is an astrophysicist; so as he views the wholly remarkable display of the starry heavens on a winter night, he sees not only the wonder which that sight holds for all of us — but as well the sense of awe and mystery which the same sight held for men in earlier eras of human history.

Professor Brecher sought to share this perspective on the oldest science with the M.I.T. community in January, 1977, by organizing a seminar series, the contributions to which are now collected in this special issue of *Technology Review*. It is a remarkable issue in many respects: a collection which can be read and enjoyed alike by readers with much or little background in astronomy, or even in physics; a balanced sampling of archeoastronomy and astromythology — monuments, instruments, works of art, written records; serious scholarly contributions to a field which has had fewer than its share.

This is the second result in *Technology Review* of Professor Brecher's generous initiative and his close collaboration with Michael Feirtag of our Board of Editors. The first was our issue of June, 1976 — a tribute to Philip Morrison in the form of articles by six devoted friends and colleagues. The Editors are confident that this second of Professor Brecher's contributions will be as popular as the first — which is long out of print; and we express our deepest appreciation for his continuing collaboration and confidence. — *J.M.*

Kenneth Brecher

Welcome Aboard

E. R. Milardo

L. A. Phillips

We announce with pleasure two additions to the staff of *Technology Review:*

☐ Leonard A. Phillips brings ten years of experience in science writing and editing to our Board of Editors.

☐ Evelyn R. Milardo, with international training in advertising, graphic arts, and production, now appears on our masthead as Circulation Manager.

Mr. Phillips has two degrees in geology from Brooklyn College; he's edited science books for Macmillan, Ginn, and (most recently) Houghton-Mifflin; he's taught science in the Manchester, Conn., schools; and he's served as Associate Editor of *Current Science,* a school-oriented science report published by the Xerox Education Group. We're confident that readers will learn quickly to welcome the initials L.A.P. — and will soon be aware of more anonymous effects of his participation, too.

Ms. Milardo came to the U.S. from Australia, where she learned and practiced art education and advertising, and for two years in the U.S. has applied these skills to direct-mail sales. Her task here is to "spread the word" about *Technology Review* — and, of course, to help our Fulfillment Manager resolve the occasional, inevitable difficulties of subscribers whose copies don't materialize when and where they should. — *J.M.*

Letters

Antarctica: The Powers That Be

David F. Salisbury reports *("Antarctica: Geopolitical Football," March/April, p. 14)* that "legal authorities say there is little anyone can do if a country such as China moved onto the continent and began to exploit it." As a student of these matters, I have heard that legal authorities say Antarctica is simply open to exploitation, but I haven't been able to find these authorities myself despite considerable effort. I spoke directly with Mr. Salisbury and asked him what legal authorities he had in mind. None, he said.

That jurisdictional issues in the Antarctic are not resolved does not necessarily imply either a compelling need to resolve them — especially if the formula for political accord is, as in this instance, a willingness to leave certain things unsettled — or open permission for exploitation. That the course to be followed by the Antarctic Treaty powers in dealing with questions of Antarctic resources is not crystal clear does not mean that the U.S. and other Antarctic Treaty countries have in their diplomatic armamentaria nothing more than the extreme choices of war or abandonment.

Gerald S. Schatz
Kensington, Md.

Mr. Schatz is editor for the Antarctican Society of Science, Technology, and Sovereignty in the Polar Regions *(Lexington, Mass.: Lexington Books, 1974). — Ed.*

Responding to the Argo Merchant

In his article "Being Prepared for Future *Argo Merchants*" *(July/August, pp. 14-28),* Jerome Milgram states that I "mercilessly and unjustifiably attacked [all Coast Guard actions]" during the *Argo Merchant* oil spill. If Professor Milgram had bothered to read the public record before making this totally false statement, he would have found that I carefully avoided any criticism of the on-scene commander and the Atlantic Strike Team. Those men performed courageously and wisely under extremely difficult circumstances.

I did, however, criticize the Coast Guard's overall administration — an administration that had failed to put into effect a regional contingency plan of any worth. The Coast Guard personnel who dealt with the *Argo Merchant* did so in a vacuum. No strategic or logistic planning had been done to help these people. Subsequent congressional investigations have borne out this position and reforms are underway.

In my opinion, statements such as Professor Milgram's make it all the more difficult for me or my successor to deal with future spills and I hope that Professor Milgram and the editors of *Technology Review* research more carefully any future condemnations of my public statements.

Evelyn F. Murphy
Boston, Mass.

Ms. Murphy is Secretary of Environmental Affairs for the Commonwealth of Massachusetts. — Ed.

Professor Milgram responds:

The section of my article to which Secretary Murphy refers deals with the inhibitory effect on critical decisionmaking by unwarranted and untimely criticism. Obviously, Secretary Murphy did not criticize "all" Coast Guard actions and I apologize for my use of the word "all." A

better choice of words would have been "very many."

During the time that the *Argo Merchant* was spilling or leaking its cargo into the sea, Secretary Murphy was publicly critical of very many actions of the Coast Guard. For example, during the spill she criticized the preparedness of the Coast Guard for dealing with the accident. The truth of the matter is that the Coast Guard is better prepared for dealing with such accidents than any other agency in any country of the world. In spite of this, they were unable to prevent the oil pollution or clean it up in the conditions that existed. Being the best in the world simply was not good enough to do the job that Secretary Murphy evidently thought should have been done.

Those of us who are familiar with the field of oil pollution prevention and control have known for a long time that only very limited success could be expected in responding to an offshore accident in the North Atlantic during winter with available equipment and the existing degree of preparedness. It is entirely possible to extend the response capability of the nation and we have made this known over a long period of time. Being better prepared would require a larger commitment of money than has been committed to the oil pollution problem in the past. It may well be that such a larger financial commitment would be in the best interests of the nation but such matters are best discussed before or after an oil spill; not during one.

To indicate more strongly the problems that such criticism can generate, I will describe one more situation which occurred. Following the breakup of the *Argo Merchant,* it was deemed possible that the sunken bow section contained several million gallons of oil. The Coast Guard announced that they were considering a plan to blow a hole in the sunken bow section to allow any trapped oil to escape during a time when the prevailing winds and waves would move the oil offshore just as they had moved the millions of gallons of oil which had already been spilled into the sea. It is the opinion of most experts in the field of oil pollution control and effects that such an action is the best one to take under those circumstances. Although all oil spilled into the sea is damaging, the expected damage from oil which moves offshore is enormously less than the expected damage from oil which moves onto shore. If there were trapped oil in the bow section that was not released during a time when the winds and seas would move the oil offshore, enormous damage could occur if the oil were to escape from the vessel at a time when the winds were from a generally easterly direction. Secretary Murphy was publicly critical of the Coast Guard plan to release the oil during favorable winds. In addition to the slowing down of decisionmaking at a time when speed is of maximum importance, the knowledge by decisionmakers that such criticism has occurred in the past and is likely to occur in future events inhibits their taking the best course of action. Interference during an accident by state governments which are unprepared to clean up oil spills is generally best avoided and this is reflected in the laws of the nation.

The legally planned response of the U.S. to a large oil spill or potential spill is described in the National Oil and Hazardous Substances Pollution Contingency Plan. The role of state governments is clearly stated in this plan. That role is generally divided into matters considered before a spill and those considered during a spill. Before a spill, state governments are invited to furnish liaison to the Regional Response Team (made up of appropriate representatives of federal agencies) for planning and preparedness activities. This way the state governments can make their interests known in advance to the Team and are kept informed of the plans (or lack of plans) of the Team. In addition, the states can make known and commit their resources for oil spill clean-up. Since the Commonwealth of Massachusetts has no equipment or trained personnel for dealing with offshore oil spills, nothing could be committed in advance from these spills.

The plan provides that during a spill the affected state governments are invited to participate in R.R.T. deliberations.

The plan does not provide for any initiative actions of the states during a spill. Such actions are principally the role of the federal on-scene coordinator with advice from the R.R.T. and the National Response Team. The sole exception is in the use of certain chemicals such as dispersants for which advice provided by the Environmental Protection Administration is binding on the on-scene coordinator.

Secretary Murphy states that my statements make it all the more difficult for her or her successors to deal with future spills. During spills, she should not be taking any actions except those requested of her by the on-scene coordinator or the Regional Response Team. Certainly my statements cannot make such requested actions any more difficult.

More on the Argo Merchant

I believe that federal legislation giving primary responsibility to the Coast Guard for clean-up efforts, but also requiring the Coast Guard to obtain repayment from the spiller, fails to adequately address the problem of oil spills.

This approach has at least three drawbacks. First, we have assigned only one organization to deal with the problem nationwide, which results in considerable standardization of approach regardless of the conditions. Second, as Professor Milgram notes, we have not given the decisionmaker enough protection so that he can afford to try innovative techniques or even do what is reasonably and obviously necessary. And finally, the requirement for repayment to the Coast Guard requires the identification of the cost of clean-up. It is extremely difficult to determine the charges which should be made for the use of government-owned equipment. The government accounting system does not identify the cost of either owning or using equipment. To avoid this problem, the Coast Guard tends to rely on marine contractors to do its clean-up work. This is fine except that oil spills occur infrequently in any given area, and there is no present system of paying the ownership costs of specialized equipment while it is awaiting an oil spill. The net result is that the only readily available equipment is equipment designed for regular marine trades. The situation is much like having the local fire department employ local contractors to fight fires so they can send the bills to whomever started the fire. The net result is that response is slower and no one can afford a fire truck.

To relieve this situation, the Coast Guard could administratively encourage its various districts to develop independent clean-up procedures and capability. All areas of the U.S. do not have the same problems, and at current state of the art, a plurality of approaches appears to be desirable in order to promote the design of better procedures and equipment. Second, the on-scene commander must be given immediate and full authority as soon as a spill is reported, and finally, the Coast Guard should be given authority to charge the spiller not costs, but some arbitrary amount, perhaps based upon the estimated quantity spilled or some other measure which would not have to include the specific identification of costs of a particular clean-up effort.

David L. Peterson
Duluth, Minn.

Letters continued on p. 12

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President Carter and Science: Friendly Partners

Colin Norman is a Research Associate at Worldwatch Institute. He was Washington correspondent for Nature *and is a regular contributor to* Technology Review.

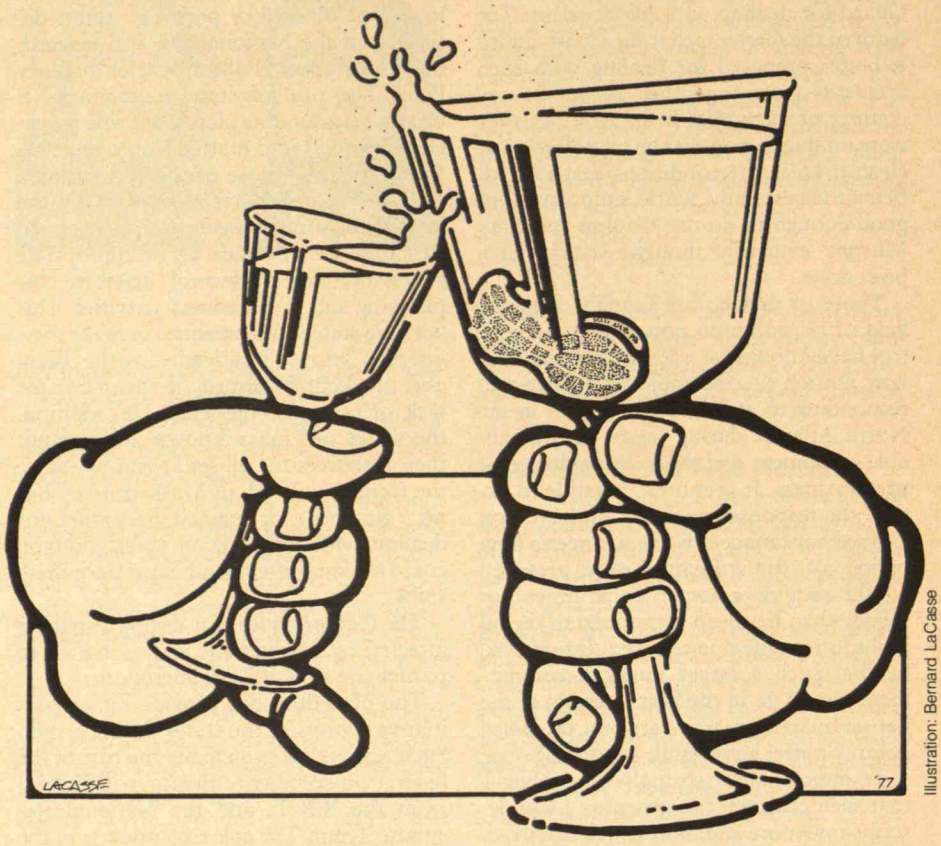

Illustration: Bernard LaCasse

Although the Carter administration has adopted no new scientific policies, it has managed to avoid the tensions and disputes that have characterized relations between science and government for the past decade.

Budgets for research and development have begun to stabilize after a period of general decline and rapidly shifting priorities. The reinstatement of a science policy office in the White House implies that the special concerns of science and technology will be considered in national policy. And some of the more outspoken critics of basic research in Congress have either left Washington or turned their attention elsewhere, leaving congressional science policy mostly in the hands of well-staffed and knowledgeable committees.

This new, more amicable partnership began during the Ford administration, when science policy machinery was brought back into the White House and the downward slide of the research budget was halted. So far, President Carter has continued those policies and soothed the elders of the scientific community, who worry constantly about the status of science and technology in the federal government.

A Niche in the Oval Office

A keenly watched barometer of that status is the position of the White House Office of Science and Technology Policy (O.S.T.P.). President Nixon scrapped his science advisory office, an act that demonstrated vividly his administration's lack of interest in technology. Under President Carter, O.S.T.P.'s political fortunes have so far been mixed, but the office does seem to have established a relatively secure and possibly influential niche.

O.S.T.P. got off to a shaky start. More than two months passed before Mr. Carter named a director for the office (who serves as the President's science adviser), a delay which prompted a few predictable grumbles that O.S.T.P. evidently ranked low in the White House pecking order. However, Mr. Carter's eventual choice — Frank Press, Head of M.I.T.'s Department of Earth and Planetary Sciences — was greeted with approval, and most people seemed willing to accept the argument that his appointment was delayed as a result of the complexities of the government clearance procedure. (Dr. Press will report his agenda for science and engineering in the *Review* for January.)

Dr. Press was immediately faced with a critical challenge. During the election campaign, Mr. Carter promised to prune and streamline the federal bureaucracy, and he decided that the place to start should be his own Executive Office. A small reorganization team was set to work on a plan to revamp the constellation of offices which constitute the President's advisory and executive staff. In the early days of its work, the team was disposed to recommend the abolition of O.S.T.P. as a separate entity; in the end, it recommended that O.S.T.P. should be preserved, and its staff and responsibilities reduced.

The reorganization plan leaves O.S.T.P. with a staff of 22, ten fewer than Congress authorized. It also divests O.S.T.P. of the responsibility for preparing an annual report and a five-year outlook on major problems facing science, technology, and public policy. (Since the National Academy of Sciences is likely to be asked to produce the forecast, and the National Science Foundation to prepare the annual report, there will be no net savings in government funds.) In addition, the reorganization plan eliminates the President's Committee on Science and Technology, a top-level committee chaired by the science adviser, which Congress established to look into the organization and health of federally funded research and development.

Day-to-Day Advice

The loss of these responsibilities strips O.S.T.P. of most of its mandate to conduct long-term analyses, central to the mission Congress envisaged for the office when it was established by legislation last year. But at least the reorganization plan leaves intact O.S.T.P.'s responsibilities for

providing day-to-day advice to the President. In fact, Dr. Press' status in the White House — already high given his considerable access to the President and his good working relationship with other White House units — has not been damaged by the reorganization plan.

It is difficult at this early stage to assess O.S.T.P.'s influence on current federal policy. The office has been assigned a number of studies: for example, an analysis of dam safety regulations and a review of basic research policies in mission agencies. But its role and influence in decisions affecting military research and development and energy policies which claim the bulk of the federal research and development budget is believed to be relatively small.

Inevitably, O.S.T.P.'s performance will be judged by the scientific community in terms of the Carter administration's budgets for science and technology, the first of which will be made public in January. Although most recent studies of federal support for basic research note that inflation has eroded budgets to below the level of the late 1960s, the two budgets presented by President Ford halted the slide by proposing an increase slightly above the projected increase in the cost of living.

In the last decade, such big projects as the Apollo program, the space shuttle, cancer research, and the construction of major high-energy physics facilities were initiated. While research budgets grew, these projects could be accommodated without creating severe distortions in the distribution of research support. But recently, big science enterprises have squeezed out less politically visible projects. For example, the space shuttle's rising overhead has caused N.A.S.A. to scrap or scale down plans for a vast range of other space science programs. Political support from new projects is difficult to muster, and we can foresee no return to the Apollo mentality.

President Carter's budget proposals will thus be the litmus test of his professed — and in many ways, already demonstrated — faith in the contributions of science and technology to the national welfare. At this point, the prospects for a continuing amicable partnership of science and the executive branch are very good. □

Robert C. Cowen

New Cryptography to Protect Computer Data

Robert Cowen, Science Editor of the Christian Science Monitor, *writes regularly for* Technology Review. *He is former president of the National Association of Science Writers.*

Len Adleman, Ronald Rivest, and Adi Shamir of M.I.T.'s Laboratory for Computer Science will pay $100 to whomever first decodes their secret message. They want to test what they think is a virtually unbreakable code which could protect a bank account, medical records, and other private information threatened by computer "crime" — unauthorized entry to electronic data handling systems.

Their challenge, first reported by Martin Gardner in his Mathematical Games column *(Scientific American,* August, 1977) is repeated on the facing page.

Dr. Rivest and his colleagues are not concerned only with safeguarding data banks. They anticipate a time when electronic mail will be routine. "What will prevent eavesdropping?" they ask. How will your correspondent know that the electronic impulses that constitute a "letter" really come from you? How will your bank know that you, and not someone else at a remote terminal, has written an electronic check on your account?

A method suggested by Martin Hellman and Whitfield Diffie of Stanford University promises to provide the electronic equivalent of sealed envelopes and personal signatures. In fact, says Dr. Rivest, the encoding schemes should be more secure than paper envelopes and the electronic signatures should be practically impossible to forge.

What Dr. Hellman calls a "mathematical revolution" underlies this audacious claim. But you won't have to be a math wizard to use the system. "The high-powered mathematics will be invisible to the user. It will be incorporated in the microcircuits of computers," explains Len Adleman. Such coding schemes should be as easy to use as a pocket calculator or the bank card that lets you draw money from a cash dispenser.

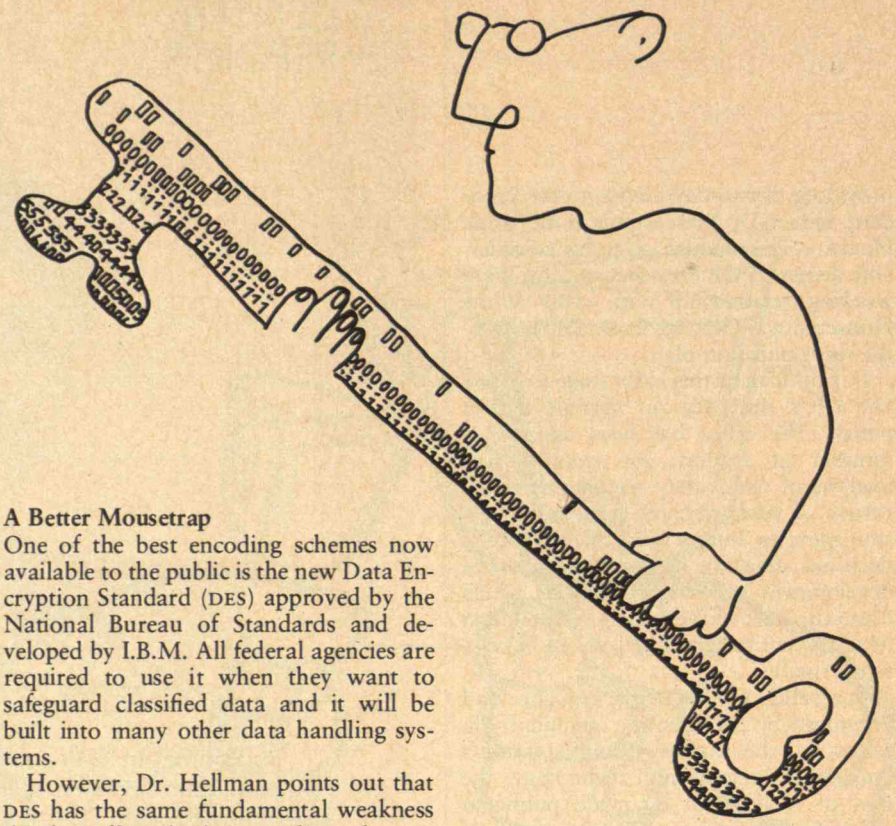

Illustration: Michael Crawford

A Better Mousetrap

One of the best encoding schemes now available to the public is the new Data Encryption Standard (DES) approved by the National Bureau of Standards and developed by I.B.M. All federal agencies are required to use it when they want to safeguard classified data and it will be built into many other data handling systems.

However, Dr. Hellman points out that DES has the same fundamental weakness that has afflicted other encoding schemes: it uses the same key both to encode and decode information. This key is a 56 binary digit number chosen randomly by each DES user (actually, the computer generates the number). That number tells a computer how to scramble and unscramble information.

While DES is more secure than most other publicly available encryption systems, Dr. Hellman maintains that a determined spy could break it by building a computer that would try all combinations of 56 digits until it hit upon the key. There are other experts who think Dr. Hellman is exaggerating. They contend it would be too cumbersome and expensive to build such a code-breaking machine. That, Dr. Hellman acknowledges, is an arguable point. What is beyond dispute is the fact that any system employing the same key both for encoding and decoding is just too awkward for everyday use. "If I want to send you an encrypted message, I first have to send you the key," he explains. "That key could be discovered, in transit or otherwise, and used by someone else. Also, such a system would be unworkable for a complex network of users [say on the order of the present telephone system]."

The Hellman-Diffie method avoids this problem by using different keys for encoding and decoding information. The two keys are mathematically related. But recent mathematical research suggests it is so difficult to derive the decoding key — even when the encoding key is known and copies of both the ciphertext and corresponding cleartext are available for comparison — that the coding is unbreakable for all practical purposes.

In what Drs. Hellman and Diffie call a "public-key" encryption system, all users would publish their encoding keys. There might be a key directory analogous to the telephone book. But the decoding keys would remain secret, locked inside the circuitry of the user's computers. For any user to send a message to any other user, he or she need only look up the recipient's encoding key in the public directory and use that key (a long number) to encode the message. Nobody but the intended recipient (or the intended recipient's computer) could read the message because the decoding key would be secret.

The system can also provide an electronic signature by allowing the user to reverse the encoding and decoding keys. For example, if I send a message to you (say a check), I would first scramble it using my personal decoding key. Then I would further scramble by using your published encoding key. When you had deciphered the message with your decoding key, it would still be unreadable because of the double encryption. Then, knowing it to be a check from me, you would use my public encoding key to turn the message into cleartext. Since you had to use my encoding key to extract the message, this would be solid evidence that the message had originally been scrambled with my secret decoding key. Since no one else could have sent you such a doubly-coded message, this would be equivalent to my signature.

The belief that such a public-key encryption scheme is secure arises from the developing theory of computational complexity, which tries to specify how much time and other resources computers need to solve problems. This research is inspired by Alan Turing, a British logician who demonstrated 40 years ago the fundamental limitations on what computers can accomplish, independent of the design of particular machines. Like the second law of thermodynamics or the impossibility of traveling faster than light, these limitations will hold however sophisticated computers ultimately become.

Dr. Turing showed that some problems will forever baffle computers, because in principle no algorithm can exist for solving them. Other problems are theoretically solvable, but in principle no "suitably fast" algorithm for solving them can ever be found. For practical purposes, these too are intractable.

The functions used for the public-key encryption schemes are considered to be of this sort. Some of them belong to a class known as NP-complete problems: NP for nondeterministic polynomial time. One such problem is that of a traveling salesman who wants to visit all the cities in his territory and return home, traveling the least total distance in the process. With only a few dozen cities on his list, the problem becomes hopelessly complex. It looks to be impossible for any battery of computers now or in the future to solve the problem without running continuously for thousands, perhaps millions, of years.

How to Factor a 200-Digit Number?

A detailed explanation for laypeople of this important and burgeoning field of mathematical research has been written by Ronald L. Graham and Michael R. Garey in the *1978 Yearbook of Science and the Future,* recently published by Encyclopaedia Britannica, Inc. Certainly, if anyone ever finds an algorithm to solve one NP-complete problem in reasonable time, then such algorithms could in principle be found for all. That feat now seems highly unlikely. As Messrs. Graham and Garey note, "Demonstration that a problem belongs to the class of NP-complete problems is widely accepted as a demonstration of its intractability."

This is good news for cryptographers. It means that the encoding-decoding keys used in schemes like those developed at Stanford and M.I.T. do provide security. It is easy to generate such keys as matching pairs. But trying to derive one of these keys, knowing only the other, may mean solving an NP-complete problem.

Dr. Hellman and his Stanford colleague Ralph Merkle have developed a practical version of a public encryption system which they are patenting. At this writing, they had not made its details public. However, the Rivest-Shamir-Adleman system has been published both in *Scientific American* and in a Laboratory for Computer Science report *(see right)*. This system depends on the difficulty of factoring numbers which are the product of two large prime numbers. A prime number is one that can be divided only by itself and one.

The published encryption key is a pair of positive integers, call them E and N. The secret decoding key is another pair of integers, D and N. It's the same N in each case, so only D is secret. N is the product of two very large random prime numbers, P and Q. The M.I.T. group recommends using 100-digit prime numbers so that N is a 200-digit number. P and Q remain secret (in fact, they can be thrown away). Nobody then can find them because, although N is published, it is very difficult to factor and is thus the heart of the scheme's security. You then choose the number D — the secret part of the decoding key — to be another large random number which has no common divisors with the product of (P-1) multiplied by (Q-1). Any prime number larger than P or Q and less than this product will do. But, the authors warn, it is important to choose D from a large enough set so that a cryptanalyst can't find it by direct search. The number E, the second part of the published encryption key, then is derived from D,P, and Q by a complex manipulation.

All this sounds complicated, but it can be accomplished in seconds by algorithms encoded in microcircuits. In practice, Dr. Rivest explains, the code might be a key function on a pocket calculator. And as long as the factoring of large numbers remains an intractable mathematical problem, this encryption scheme is virtually invulnerable.

The M.I.T. team issued its challenge because mathematicians have not yet proved that the factoring problem is intractable in principle. So the best way to test the code is to see if anyone can break it. However, Dr. Rivest says it may only be a matter of a few years before mathematicians do show that this class of problems is intractable. In that case, Dr. Hellman believes that however sophisticated and clever computers become, an easy-to-use and practically unbreakable cryptographic system will be able to safeguard privacy.

The $100 Secret Message

9686	9613	7546	2206
1477	1409	2225	4355
8829	0575	9991	1245
7431	9874	6951	2093
0816	2982	2514	5708
3569	3147	6622	8839
8962	8013	3919	9055
1829	9451	5781	5154

The first person to decode this secret message will win $100.

The message is encoded according to a scheme devised by Len Adleman, Ronald Rivest, and Adi Shamir of M.I.T.'s Laboratory for Computer Science to protect computer data banks from unauthorized entry. The scientists believe the code improves upon existing schemes and are betting $100 that it will prove virtually unbreakable.

A message represented by the number M is enciphered as $M^s \pmod r$ where s is 9007 and r is 11438162575788886766923577997614661201021829672124236256256184293570693524573389783059712356395870505898907514759929002687954354 1. The enciphered version of M above is the remainder when M^s is divided by r.

The challenge first appeared in Martin Gardner's "Mathematical Games," *Scientific American,* August, 1977 (all rights reserved). So far, the team has not received a successful response.

Cryptography and National Security

Unfortunately, Big Brother has stepped in and threatens to withdraw the system from the public domain. In late September, *Science* reported that J. A. Meyer, apparently an employee of the National Security Agency (N.S.A.), is trying to silence Drs. Hellman, Rivest, and other scientists working on public-key encryption schemes. In a letter to the Institute of Electrical and Electronic Engineers (I.E.E.E.), he suggested that publishing the schemes violates federal law and urged I.E.E.E. to cancel a seminar on the subject. I.E.E.E. forwarded the letter to the scientists planning the symposium. At this writing,

Continued on p. 12

Energy Policy: A Piece of Cake

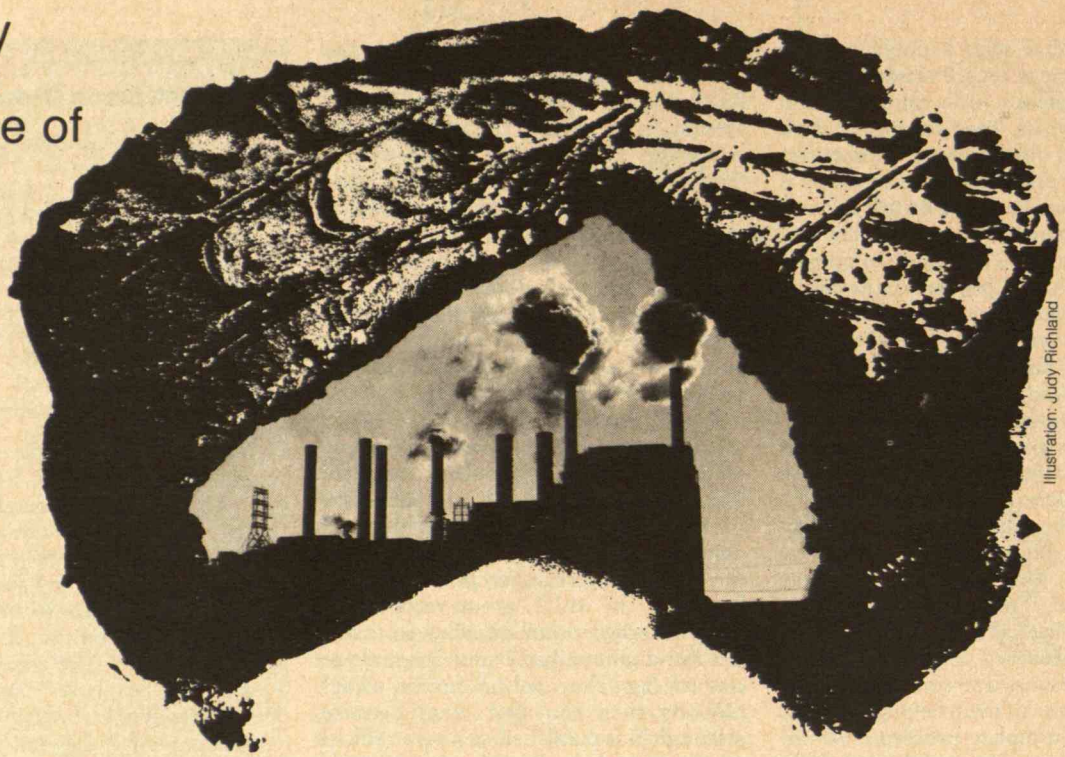

Illustration: Judy Richland

Kenneth E. Boulding is a director of the Institute of Behavioral Science and Professor of Economics at the University of Colorado at Boulder. He is a regular contributor to Technology Review.

When someone proposes that we need an energy policy, a million heads nod in solemn agreement. Obviously we need energy. Almost certainly it will become scarcer and more expensive. We have become and are likely to remain highly dependent on imports. Yet there is not much sense of an immediate crisis: gasoline is in fact relatively cheaper than it was 40 years ago; there are no lines of cars at the pumps; we have almost forgotten the shortages of last winter. We may sense a cliff somewhere in the neighborhood, but it is sufficiently distant that we pay it little attention. Even so, do we really need an energy policy?

Energy is a long-run problem. Oil and natural gas are expected to be virtually exhausted in the lifetimes of our children. Coal, nuclear and solar energy, and such sources as biomass, geothermal, and wind all have drawbacks, some of them very serious indeed.

The case for an energy policy is strong —too strong, in fact, and that is just the trouble. All production involves energy, but it also involves know-how and materials: three layers of a great cake. Policy must come in slices, not layers, and it is a rude hostess who offers a guest a layer of cake rather than a slice.

An energy policy is a layer, not a slice. All problems involve energy, so energy is too broad a category to define them. At the same time, all problems involve other issues besides energy, so the category is also too narrow. Energy is a problem of depleting resources. But materials are depleting, as well, and thus are also a potential constraint on production. In fact, some materials — for instance, water — may be ultimately more limiting than energy. So if we concentrate too single-mindedly on energy, we may overlook the possibility that we will never exhaust our energy resources, simply because we will exhaust materials first. For instance, evolution apparently ceased on the moon at about the level of a crystal because water and perhaps carbon were absent. The moon certainly had energy, yet it was useless because material limitations preempted the process.

Energy and materials are bound together. Without an increase in energy supply, aluminum and titanium could not have been developed; metals of all kinds would have been virtually impossible without fire, and thus without wood. Similarly, the discovery of new materials may extend energy resources. For instance, the solution to the fusion problem may depend much more on materials than on energy. The problem is not energy but resources: energy, materials, even knowledge, legitimacy, and morale.

Energy has had far too much attention. The Department of Energy will almost certainly cause us to neglect equally difficult problems of materials and know-how. A Department of Exhaustible Resources would be much more rational. And a Department of Applied Research would perhaps be the most sensible solution of all, for our problems are interdependent.

No matter how we slice the cake, the slices will be rather arbitrary, determined just for the sake of administrative order and convenience. But at least each slice should comprise all the layers, and for this reason the Department of Energy is precisely the wrong way to cut the cake. It would be very surprising to find a business firm with a department of energy, for energy must be in the purview of all departments.

Can what is absurd in business be sensible in government? □

A Creative Elite in the White House

Sputnik, Scientists, and Eisenhower: A Memoir of the First Special Assistant to the President for Science and Technology
James R. Killian, Jr.
Cambridge, Mass.: M.I.T. Press, xix + 395 pp.; $14.95

Reviewed by Victor K. McElheny

In 1954, during the early days of the hydrogen bomb, President Eisenhower met with the Scientific Advisory Committee of the Office of Defense Mobilization to hear out the committee's concerns about the inadequacy of American military technology.

As James R. Killian, Jr., relates in his account of scientific advice to the White House in the 1950s (*see excerpt, pp. 10-11*), President Eisenhower had a concern of his own: surprise attack against the United States.

Could a closed society like the Soviet Union plan a crushing attack in secrecy? Pearl Harbor was only 12 years in the past and Hiroshima and Nagasaki less than nine. The intercontinental ballistic missile, launched from concrete silos or roving submarines, was not yet a military reality.

Faced with this challenge from the American President having the most completely military background — who proved notably skeptical of the claims of weapons-builders — the committee of technical people schooled by the pressures of World War II saw an opportunity for a focused review of America's technical strengths and weaknesses in national defense.

Dr. Killian was named chairman of the task force that studied over the next nine months the elements of warding off surprise attack in the nuclear age.

The Valentine's Day Report

It was fitting that the group was named the Technological Capabilities Panel. Its task inevitably drew it toward such broad topics as defense against an attack if one occurred; the means for delivering a damaging retaliation; the intelligence needed to assess enemy capabilities and intentions; the adequacy of communications to bring information swiftly and securely to military forces and their civilian chiefs; and the supply of technical talent needed to assure American military strength.

Starting from the relatively narrow intellectual focus of defense against surprise attack, Dr. Killian and his colleagues were pulled to consider the strength of the nation's scientific enterprise — which is not only vital in military matters but also in enhancing the nation's ability to provide meaningful work for its people. This progression foreshadowed the development of the White House science office (founded with Dr. Killian as its first chief after Sputnik I was launched) from an engine for stimulating needed weapons development into a tool for encouraging space exploration and arms control. Finally the office began to stimulate the fundamental research from which future wealth would spring, although Dr. Killian expresses regret that more was not done.

As Dr. Killian recalls, the Technological Capabilities Panel was the first to produce "a coordinated, symmetrical comparison of U.S. and Soviet military positions." The Panel's report, presented to the National Security Council on Valentine's Day, 1955, after a full rehearsal staged by Robert Cutler, said that while the U.S. seemed vulnerable to surprise attack, it should soon move into a period of "very great offensive advantage relative to the U.S.S.R." and should seek to prolong that advantage by pushing "all promising technological development."

Bold Decisions

The Panel foresaw a danger as early as 1958 if the Soviet Union succeeded in developing practical multi-million-ton hydrogen weapons and a large fleet of attack bombers before the U.S. could install an adequate early-warning and air defense system. The Panel urged that the U.S. install the system without waiting for refinements.

The Panel's report, together with a report of the Air Force Strategic Missile Evaluation Committee, led President Eisenhower to approve, for the first time during peace, a "highest national priority" for developing intercontinental missiles.

The Panel favored intelligence-gathering as a means "to help resolve with hard facts the contending views and fantasies that inevitably appear in our democratic processes." Thus it backed the proposal — hitherto disapproved — to build a long-range, high-flying reconnaissance aircraft, the famous U-2.

Afraid of "leaks," President Eisenhower demanded that Dr. Killian and Edwin H. Land, head of the Panel's Intelligence Section, discuss this and other secret recommendations with him privately. After approving the U-2 idea, President Eisenhower demanded that the project be managed directly by the Central Intelligence Agency to free development from military service rivalries and the ponderousness of the Pentagon.

James R. Killian, 10th President of M.I.T., was featured on *Technology Review*'s cover for December, 1957, as he conferred with members of the press following his appointment as President Eisenhower's Special Assistant for Science and Technology. (Photo: Louis R. Nelson)

President Eisenhower's enthusiasms for the U-2 and his approval of the Stanford Linear Accelerator Center and of the high-altitude Argus explosions of 1958 — made to test theories about the earth's magnetosphere — are cited by Dr. Killian as examples of the President's "responsiveness to innovation and his willingness to make bold technological decisions."

Dr. Killian's memoir recalls the special circumstances that prompted President Eisenhower's extraordinary reliance on scientists to address some of his most pressing problems. Aside from the President's own receptiveness and the wave of national self-criticism after Sputnik, scientific advisory machinery was nearly absent in many executive departments and agencies and in Congress. (That deficiency has since been made up in part, while the President's ability to mobilize scientific talent has weakened.)

Bitter controversies over the war in Vietnam, the proper balance between economics and ecology, and the pace of commitment to new strategic weapons

Continued on p. 12

The Continuing Need for Science Advice

Twenty years ago, James R. Killian, Jr., President of M.I.T. and former Editor of Technology Review, *was named by President Dwight D. Eisenhower to become the first Science Adviser in the White House. In his new book* Sputnik, Scientists, and Eisenhower *(published this fall by M.I.T. Press), Dr. Killian recalls a White House tenure in which science, technology, and government maintained intimate and healthy relations (*see Victor McElheny's review, p. 9*). In the following excerpt Dr. Killian ponders the opportunities which science now has to serve national policymaking in the White House.*

Many current policy issues affecting science and technology warrant attention in today's White House. Let me suggest some of these:

☐ When viewed from abroad, American science and technology hold a position of impregnable leadership. In the halls and laboratories of our universities and in the community of science, there is worry that this leadership is being eroded. What is the evidence? As this memoir goes to press, a new study presents a dispassionate, well-researched appraisal of "The Future of Academic Science — The Universities in the Nation's Research Effort." As stated in the official announcement, this new assessment of American science, particularly of basic research as conducted by the nation's universities, indicates "continuing vitality but also warns that trouble lies ahead."

The productivity of American science today in the main had its roots in work undertaken and financed some years back. The real question is whether the current conditions described by the study's authors may inevitably result in deterioration in American science in the years ahead. We have seen in the span of a century extraordinarily rapid shifts in leadership in science and technology from England to Germany and then to the United States. It is clear that the nation has compelling reasons to take measures for protecting the future well-being of its great research universities to ensure the continuing leadership of its science and technology.

☐ The White House science advisory mechanism should be called upon to make inputs to presidential policy-making at the level of the National Security Council (N.S.C.). I do not recommend that the science adviser to the president be a member of the National Security Council, but I do propose that he be invited to attend appropriate meetings, as both George B. Kistiakowsky and I were during the Eisenhower administration. . . .

☐ It is also important that the White House science advisory resources have an opportunity to indicate those areas of foreign policy strongly affected by scientific and technological considerations. In *A World Destroyed: The Atomic Bomb and the Grand Alliance,* published in 1975, Martin J. Sherwin provides a dramatic example of how the absence of adequate science advice can have fateful results. His researches indicate that President Roosevelt came to concur with Churchill's views that atomic energy should be kept as an Anglo-American monopoly — an objective "that [Vannevar] Bush considered unattainable and therefore disastrous to pursue." Despite the fact that Bush had worked so closely with Roosevelt as his science adviser during the war, it appears that in regard to international relations, neither he nor James Conant were called upon for any advice. Surely Roosevelt should have had advice that would have made clear to him that such a monopoly could not be maintained.

There was also an unfortunate lack of scientific guidance for President Truman when he participated in the Potsdam Conference, when the timing of that conference coincided with the atomic bomb test in New Mexico. This circumstance, along with the decision not to inform the Russians about our achievement of the atomic weapon, may have been decisive in preventing international control of the bomb.

☐ Many of the problems confronting our society require new institutional arrangements for their study and solution. To meet our defense and space needs, we have invented new organizations such as the large, university-based, interdisciplinary laboratories. We have in the service of defense an extraordinary array of institutions, the "think tanks," the systems engineering not-for-profits, and so on. As Don Price has shown, these institutional inventions and arrangements with the universities and industry have brought into being "federalism by contract." Do we not need to invent innovative institutions to deal with non-defense problems? . . .

A number of universities have launched new centers or laboratories devoted to energy studies and research. To the detriment of the nation's energy program, they have found it discouragingly difficult to get funds except in homeopathic amounts. We are not using well the high professional skills available in our universities.

☐ The universities need to be encouraged to create new educational entities that can provide a new kind of education and new coalitions of scholars designed to prepare men and women for their responsibilities in our technological society. This means a new kind of liberal education which Sir Eric Ashby has described as treating "technology as inseparable from humanism." To meet their current responsibilities, the government and our society need the services of engineers who have achieved a mastery of their specialties but who in addition have the vision and motivation to use and shape technology as a powerful instrument for enhancing the quality of our society. The education and use of such engineers should be high on our national agenda. I think of engineers such as Vannevar Bush, who demonstrated great qualities of leadership effectively exercised in the public arena.

☐ I give special importance at this time to the formulation of government policies designed to encourage the science and technology that can contribute to the rejuvenation of our economy. I regret that the P.S.A.C. of my day did not devote attention to the health of the economy. Robert G. Gilpin, Jr., Professor of Politics and International Affairs at Princeton, in a report for the use of the Joint Economic Committee of the Congress, recently presented an eloquent argument for rejuvenating our technological vitality through thoughtful changes in the nation's priorities in research and development funding. Priorities, he maintains, have been "too much set by the Cold War and a drive for national prestige."

An American Climacteric?

In an editorial in *Science,* Raymond L. Bisplinghoff, formerly with the National Science Foundation, pointed to another aspect of the allocation of federal research and development funds: "Until recently, the preponderance of federally supported research and development was targeted to military, space and other objectives, where the government itself was the primary customer. Most of the present national research institutions, laboratories, and management policies have evolved since World War II with this direction. But we have now entered a new era in which the federal government will not be the primary customer. The new customers are industry, local government,

and private citizens. The proportion of research and development directed to the civilian sector has increased from 23 to 35 per cent over the last six years, and it will undoubtedly grow in the future with the growth of government involvement in energy, transportation, food production, recovery of nonrenewable natural resources, environmental protection, and a host of other areas involving the private sector. But an important policy question is not being faced. It is not at all clear that funneling federal research and development funds through existing federal institutions will come within a country mile of accomplishing the intended purpose."

Charles P. Kindleberger, Ford International Professor of Economics, Emeritus, at M.I.T., wrote in an article for the January-February, 1974, issue of *Challenge* under the title, "An American Economic Climacteric?":

"Analogies are dangerous. At the same time, if apposite, and treated gingerly, they can be instructive. In the last several years, I have been struck by the analogy between the 'climacteric' in the British economy at the end of the last century, reflected in its inability to turn back the economic challenges of the United States and, especially, of Germany, and the slowing down of the United States economy today, under parallel challenge from Japan. The similarities are striking, though there are profound differences."

The Role of Science in Policymaking

When the Science Advisory Committee, as it was constituted by President Eisenhower, met with him in 1957, he asked the group whether we were falling behind other countries, particularly the Soviet Union. This was just after *Sputnik*. As I have recounted, the response was that American science was still unusually strong, but it could fall behind if we didn't have the proper science policies in this country; this was the kind of thing that had happened elsewhere in the past, and we could not be certain we were in a position of superiority — or could maintain such a position — unless we took unusual measures to assure and preserve the strength of American science.

The question of this country's position in world science is going to continue to come up, president after president, science adviser after science adviser; the new science advisory mechanism in the White House will thus find the question of how we maintain the quality and vitality of American science to be a matter of fundamental policymaking at the presidential level — fundamental for science and fundamental for our technology and our industrial strength.

Professor Kindleberger spoke of the way the British were overtaken after the turn of the century by the Germans and the Americans in the field of technology and industrial growth. The Industrial Revolution started in England with an extraordinary outburst of energy and intellectual vigor. Something happened, however, and the English began to fall behind while the Germans forged ahead. The Germans found it possible to bring to bear on the industrial activities of the country the resources of science and to encourage research in their universities. In a very short time, they had achieved a position of distinct superiority over the British in most areas of technology. This was an example of what the Science Advisory Committee in 1957 was talking about with the president.

In his Karl Taylor Compton lectures at M.I.T. in 1962, Isador I. Rabi . . . pointed out that when he went to Europe for graduate study in 1927, the *Physical Review,* published by the American Physical Society, was virtually unknown in Europe. Copies of the journal were received but put on the shelf until the end of the year, when they were finally unwrapped. No one was interested.

Ten years later, by 1937, American physics in particular (and American science in general) had overtaken the Europeans, and we unquestionably occupied a position of leadership. This is an example of the extraordinarily rapid change that can take place, and Rabi pointed out that one thing which led to this quick change was that a group of young Americans went over to Europe to study. These Americans perhaps knew more science than any of the students they encountered over there, he said, but this was not the major factor.

They learned that the great European scientists had a style and quality of leadership, of understanding what the important things were, that gave them their leading position. Up to that time, American scientists had not acquired these attributes, but when this group of Americans came back, they brought back that style or taste or quality and transmitted it to the universities, to their young students. That, coupled with the fact that American universities were developing strong graduate study very rapidly in the 1920s and 1930s (and largely without government funds!), led to a great output of first-rate scientists in this country. Hence, by the time World War II came, we had a tremendous array of scientific talent.

The Antitechnology Campaign

Today we face a circumstance where many anti-intellectual forces are operating to denigrate or hamper science in this country. We must try to counteract these influences so that we maintain this vitality, this taste, this quality about which Rabi spoke. That, I think, is one of the principal problems that now face government policymaking with respect to science and technology.

The policymaking leaders of our government are confronted with other policy issues in which objective scientific advice is needed if they are to be wisely resolved. Most are obvious: the development of better energy and environmental policies and regulations based upon sound analysis and technical understanding; the beneficial allocation of funds to different kinds of research and development programs; the preparation for arms limitation negotiations and the design of systems to safeguard disarmament agreements; the development of replacement technology and technology grown obsolete or socially undesirable; the reconciliation of technological advance with a healthy society and a benign environment; the incorporation of both human values in environmental decision-making and an adequate understanding of the underlying technology. In addition to these, our support of basic research and of research and development to increase productivity has seriously declined as a result of inflation, reduced government support, and increased red tape. The government needs to take a hard look at its overall science budget and its priorities.

Presidential leadership is needed to counter the antitechnology campaign that has had destructive effects in recent years. The attacks on technology have diminished as recognition has grown that humane technology is essential for the solution of many of our most pressing environmental and social problems, but there is still need for the intellectual leadership that can restore faith in the nation's ability to generate and use technology for the "human use of human beings." Eisenhower exercised intellectual leadership in strengthening science in the post-*Sputnik* period.

Scientists and engineers alone by no means have the answer to this array of problems, but I do maintain that we need an advisory coalition that includes lawyers, economists, foreign affairs experts, social scientists, *and scientists,* all working under the direction of generalists who do not denigrate or favor any one of these professional groups.

Cowen

Continued from p. 7

lawyers for M.I.T. and Stanford are still studying the question and it is not known how the scientists will respond, if at all. But it seems unlikely the symposium will be cancelled.

Mr. Meyer's letter is a silly attempt at censorship. The relevant law, the Arms Export Control Act, does classify some cryptography as military technology. The I.E.E.E. agenda does include cryptographic schemes that might be exported. But attempts to suppress free discussion of unclassified academic research on these grounds seem ludicrous, especially when all of the important information has already been published.

The N.S.A. does deny that Mr. Meyer wrote on behalf of the agency. Even so, his letter underscores the need to protect individual privacy. The N.S.A. has been caught intercepting private telephone conversations of U.S. citizens already. Now an encoding scheme that might protect such conversations is being developed and an employee of the agency steps in and tries to suppress it. □

Books and Comment: McElheny

Continued from p. 9

systems divided the scientific community and alienated many prominent presidential scientific advisers. Although the public's actual dependence on sound, dispassionate scientific expertise was increasing, the apparent mistakes of those in authority paradoxically reduced the public's trust in science and technology and led to excessively political and legal approaches to protect the public from present and future environmental health risks. Perhaps the same attention that was given in the late 1950s to focusing the nation's talent on a rational program of defense, research, and engineering is needed now in assessing the human health risks from advanced technology.

Dr. Killian's account is fascinating in its recall of the processes of thought by which the important technical questions of the late 1950s were articulated and addressed. Pervading those thought processes was a kind of civic sobriety, an apparent need to agree in order to serve the public, that is often lacking today. Dr. Killian locates that attitude's source in the great school that was World War II. Of the members of the President's Science Advisory Committee that served Eisenhower, Dr. Killian writes that they were "mainly seasoned scientists and engineers who had been deeply involved in World War II weapons research and development. They had been tested in the crucible when applying scientific approaches to military problems under the urgencies of war."

Dr. Killian adds that these scientists "would have rejected as repugnant and ridiculous the idea that they were a priesthood, a term that has been used to describe the scientists who undertook public service in that period. They did not consider themselves part of an establishment." Dr. Killian calls these scientists "a creative elite rather than a power elite."

It is a pity that today's more profound questions — how the nation can maintain a reasonable prosperity in the face of rapid, worldwide economic development — do not concentrate our minds as wonderfully as the apparently narrow questions of defense against a Soviet surprise attack did 20 years ago.

Victor K. McElheny writes about technology for the financial department of the New York Times. *He has written frequently for* Technology Review *and was associated with* Science *magazine in Washington at the time of Dr. Killian's appointment to the White House Staff.* □

Letters

Continued from p. 3

Sulfur Dioxide and Urban Trees

A serious mistake appears in the table and text on page 33 of Ruth Foster's "Roots: Caring for City Trees" *(July/August, pp. 28-35).* SO_2 is not sodium dioxide but sulfur dioxide.
Ricardo O. Bach
Bessemer City, N.C.

Mr. Bach is Manager of the Research Department of Lithium Corp. of America. The error was made by the editors, who stand corrected (and chagrined). — Ed.

The Leader's Power

Warren G. Bennis cries in dismay, "Where Have All the Leaders Gone?" *(March/April, pp. 36-46).* But when people follow a leader, he is tempted to lead them into war. What better way to achieve absolute power? I feel proud that the majority of people in this country are confident, strident, imaginative, altruistic, individualistic, and competently able to deal with fragmentation.

Where have all the leaders gone? Let's beware what we are wishing for. I pray: "God save us from another leader. Long may one not arise!"
A. E. Walker
McLean, Va.

simulation system modelers and analysts

for real time simulators of nuclear and fossil fuel power plants

Electronic Associates, Inc. (EAI), a world leader in the design and manufacture of simulation and computation equipment, is located in the highly desirable Jersey Shore area. Our success in capturing challenging new contracts has created these immediate openings for Systems Analysts with the following background and experience:

SENIOR LEVEL

These positions carry responsibility for the formulation and execution of major projects, as well as some proposal writing and making presentations to prospective customers.

INTERMEDIATE LEVEL

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An Oscillating Piston Since 1940

Allan J. Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now Assistant Professor of Mathematics and Coordinator of Computer Activities in the Mathematics Department at York College of the City University of New York. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y., 11451.

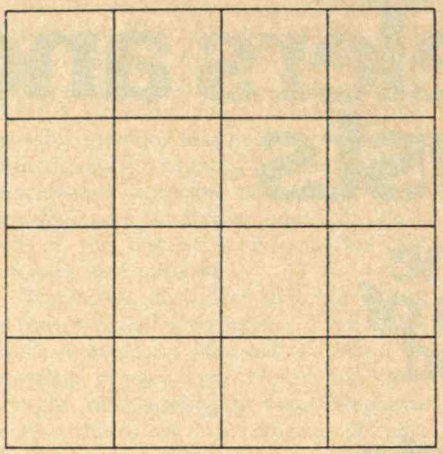
Though at times last year some skeptics doubted it could happen, C.U.N.Y. classes have begun this fall, and York College has continued its policy of accepting unusual freshmen: for some reason their average age remains constant, but every year they look younger. I wonder how that happens.

Several readers have submitted interesting letters. Neil Cohen reports that a letter of his to columnist D. Keith Mano concerning a marriage problem in "Puzzle Corner" resulted in a column on stable marriages. Jerome J. Taylor asks some common questions about computer chess, and since they appear to be of general interest, let me answer them here. A computer program as world chess champion is not imminent. I expect this to happen in my lifetime (a controversial expectation), but I am watching my diet and not smoking to increase the likelihood. Specifically, humans will easily hold on for ten years; but this century will most surely be the last without a computer champion — unless it is the first century to have one. However, neither computers nor humans will be able to "solve" chess (i.e., consider all possible outcomes) before the sun "burns" out! Judith Q. Longyear destroys NS 8 (see solutions section) and reports the pleasant news that she has received tenure at Wayne State. Congratulations!

Problems

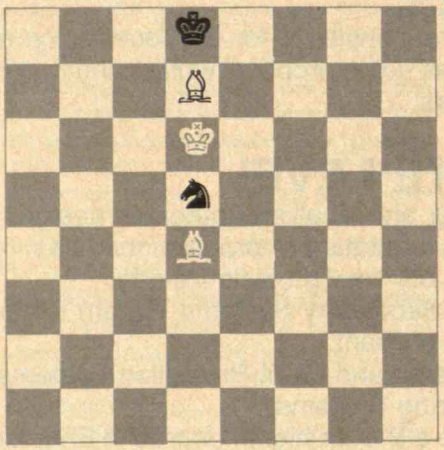
NS 9 This problem, from George L. Uman, originally appeared as **1972 DEC 3**. There was no solution then; can we have one now?

In each of the 16 squares of the figure, place a *different* letter, selected so each row, column, and long diagonal will spell



a *different* four-letter word when the letters are selected consecutively in one or the other of the only two possible directions, as we do with numbers. There will be a total of ten different words, all of which must be defined in any one edition of Webster's dictionaries.

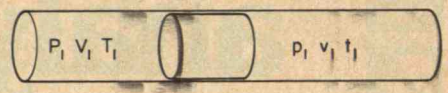
DEC 1 Our first new offering is a fairly simple chess problem from Glen Ferri:



White to play and mate in two.

DEC 2 The following from J. L. Friedman appeared in a series of advertisements published in *Technology Review* by Calibron Products, Inc., of West Orange, N.J., back in 1940:

The ends of a closed cylinder, fitted with a leakproof, frictionless piston, are filled with perfect gases having the initial pressures, volumes, and temperatures indicated. If all of the walls are perfect heat insulators, where will the piston finally stop? Three students propose three answers: A says it will stop where P = p, using adiabatic processes. B says the piston will oscillate perpetually. C says: even though heat does not flow *through* the piston, the piston itself will act like a big molecule, and (after many oscillations) the pressures *and temperatures* will equalize. Who is right? Other possibilities?



DEC 3 Frank Rubin wants you to replace each letter by a unique digit to obtain a valid addition:

$$\begin{array}{r} \text{FIVE} \\ \text{TWO} \\ +\ \text{ONE} \\ \hline \text{EIGHT} \end{array}$$

DEC 4 Peter Hadley has an interesting result in number theory for you:

It is well known and easily proved that the differences between consecutive perfect squares are always odd numbers and that the difference between two consecutive differences will always be 2, which equals 2! It is also true that the differences of the differences of the differences of consecutive perfect cubes is always 6 = 3! In fact, this pattern holds for all natural numbers and zero; i.e., (the differences of)^n consecutive perfect nth powers is n! Below are several arrays which attempt to demonstrate this more clearly. The bottom line consists of consecutive integers all raised to the same power. Each higher line consists of numbers each the difference of the two numbers beneath it. Note that after making the same number of subtractions as the power in the bottom row, we obtain a row all of whose elements are the factorial of that power. Prove that this is so.

	2	2	2	2	2	2! = 2
1	3	5	7	9	11	
0	1	4	9	16	25	36
	6	6	6	6		3! = 6
6	12	18	24	30		
1	7	19	37	61	91	
0	1	8	27	64	125	215
	24	24	24			4! = 24
36	60	84	108			
14	50	110	194	302		
1	15	65	175	369	671	
0	1	16	81	256	625	1296

DEC 5 John T. Rule offers the following geometry problem: Given two sides, construct a parallelogram whose angles are equal to the angles between its diagonals.

Speed Department

DEC SD1 Leo Santori wants you to draw eight equal-length non-intersecting lines which define two squares and four triangles.

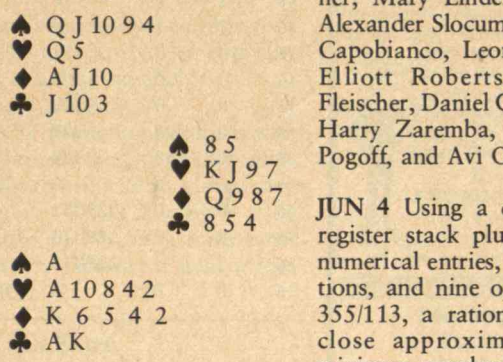
DEC SD2 Joe Horton submits a quickie I often use at cocktail parties:

Add a single straight line to the following "equation" transforming it to a valid equation (*not* an inequality).

1 = V1

Solutions

JUN 1 You are South, the declarer, with a contract of three no-trump. West opens with ♣6. How do you play the hand?



Apparently the key to this is to discard the ♣A on the fourth trick; after that, it's not too hard. The following is from R. C. Evans:

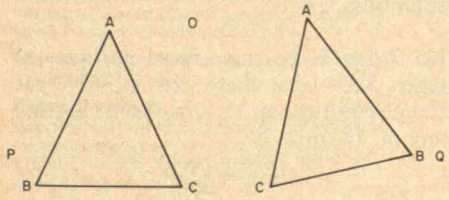
South takes the opening lead of ♣6 with ♣K. He plays the singleton ♠A at trick 2. He then crosses to the dummy's ♦A, lays down the ♠Q and jettisons his ♣A. The opponents can take the ♠K, ♣Q, one heart, and one diamond for a total of four tricks. Declarer takes nine tricks to fulfill the contract.

Also solved by Hilda Gilinson, Emmet J. Duffy, R. Robinson Rowe, Smith D. Turner, Stuart Schulman, M. F. Colaco, Mark Chen, William J. Butler, Jr., Elmer Ingraham, Peter Groot, Dave Windsor, and the proposer, Russell A. Nahigian.

JUN 3 Prove that the base angles of an isosceles triangle are equal without constructing an angle bisector.

The following is from Frederick Hooven (with help from Marc Kac and an unnamed computer):

Professor Kac was reporting, along about 1964, the results of having programmed a computer to perform the proofs of Euclid's propositions, which it performed in more or less the conventional way until it came to this one. He also reported that this proof had been found later in some old texts. In the diagram below the plane OPQ contains the isosceles triangle ABC. ABC is inverted by rotation through 180° about an axis contained in the plane OPQ, producing the triangle ACB. Since the two sides AB and AC are equal and the included angle A is common to both, the two triangles ABC and ACB are congruent. Therefore, angles C and B are equal. Q.E.D.



Also solved by Stuart Schulman, William J. Butler, Jr., Peter Groot, Naomi Markovitz, Frank Rubin, Winslow Hartford, R. Robinson Rowe, Smith D. Turner (∫dt), Robert Saunders, James Shearer, Raymond Gaillard, Farrel Powsner, Mary Lindenberg, Jonathan Luke, Alexander Slocum, Raymond Kinsley, M. Capobianco, Leon Bankoff, Emil Deeg, Elliott Roberts, Hal Shane, Bruce Fleischer, Daniel Grunberg, Philip Martel, Harry Zaremba, Verona Winn, Robert Pogoff, and Avi Orstein.

JUN 4 Using a computer with a four-register stack plus one storage register, numerical entries, clear and print instructions, and nine operating keys, generate 355/113, a rational number which is a close approximation to pi, in the minimum number of operations. The nine operating keys have the following functions, starting from the following initial condition of the registers:

M D C B A

The "add" instruction yields:

M O D C A + B

The "subtract" instruction yields:

M O D C B − A

The "multiply" instruction yields:

M O D C A · B

The "divide" instruction yields:

M O D C B/A

The "square root" instruction yields:

M D C B$\sqrt{A}$

The "repeat" (or "enter") instruction yields:

M C B A A

The "interchange" instruction yields:

M D C A B

The "recall" instruction yields:

M C B A M

The "store" instruction yields:

A D C B A

The shortest solution is from the proposer, B. W. Latourneau, who offers a 21-step calculation as shown at the top of the next page.

Albert A. Mullin notes that he posed a similar problem in *American Mathematical Monthly* in February, 1975, relating to the design of electric circuits; thus diophantine equations are applicable to both computer hardware and software.

Also solved by William J. Butler, Jr., Harvey Greenberg, Jacob Bergmann, Philip Martel, and Peter Groot.

0	0	0	0	1	
0	0	0	1	1	RPT
0	0	1	1	1	RPT
0	0	0	1	2	ADD
0	0	1	2	2	RPT
0	0	0	1	4	ADD
0	0	1	4	4	RPT
0	1	4	4	4	RPT
0	0	1	4	16	MUL
16	0	1	4	16	STO
16	1	4	16	16	RPT
16	0	1	4	32	ADD
16	0	0	1	128	MUL
16	0	0	0	129	ADD
16	0	0	129	129	RPT
16	0	129	129	16	RCL
16	0	0	129	113	SUB
16	0	0	0	129/113	DIV
16	0	0	129/113	16	RCL
16	0	0	129/113	4	ROOT
16	0	0	129/113	2	ROOT
16	0	0	0	129/113	ADD

JUN 5 Six width gauges are permanently mounted on a ring. They can measure any width from 0.001″ to 0.031″ in 0.001″ steps by using individual gauges or by sliding two, three, four, five, or six consecutive gauges together. Find five ways to do this, giving the widths of the gauges and their order on the ring.

The following is from Peter Groot:

Since we can start with any of six gauges and count 1, 2, 3, 4, or 5, we have 30 measurements, plus a measurement of .031″ with all six. Thus each individual gauge and each combination must be unique. There must then be a .001 and a .002, and if not together there must be a .003 in the set. From the requirement for uniqueness and sum we can construct the 21 possible sets. After some trial and error, the following solutions emerge:

.001,	.003,	.002,	.007,	.008,	.010
.001,	.003,	.006,	.002,	.005,	.014
.001,	.007,	.003,	.002,	.004,	.014
.001,	.002,	.005,	.004,	.006,	.013
.001,	.002,	.007,	.004,	.012,	.005

Also solved by William J. Butler, Jr., R. Robinson Rowe, James W. Shearer, Harry Zaremba, Winslow Hartford, Stuart Schulman, Dennis Sandow, Kenneth Wise, and the proposer, Emmet J. Duffy. Mr. Sandow reports that his SR-52 found four solutions after 93 hours, and Mr. Rowe comments that this might be considered a particular case for a set of n gauges making all incremental thicknesses from 1 to $n^2 - n + 1$ mils; and he wonders for what n besides 6 the general case has solutions.

NS 7 Let N be some fixed positive integer. Show that there exist positive rational numbers $a_1, \ldots, a_N$ such that for any m, $1 \leq m \leq N$

$$S(m) = \sum_{i \leq m} a_i^3$$

is the square of a rational number, and S(N) = 1.

Alan LaVergne has supplied a long and complex proof that no such sequence of rationals exists. Unfortunately, space doesn't permit its publication; readers who wish a copy should write to the Editors at Room 10-140, M.I.T., Cambridge, Mass., 02139. William J. Butler and Charles Richards have also responded.

NS 8 Under what additional conditions is it true that $6N + 1$ or $6N - 1$ is prime, where N is a counting number?

Judith Longyear writes:

Ha! The twin primes conjecture is that there exist infinitely many pairs of numbers x, $x + 2$ both prime. Past $x = 3$, they must be $x = 6n - 1$, $x + 2 = 6n + 1$, so this is probably an NS for a long time. Bombieri recently received a field medal for coming close.

Better Late Than Never

NS 4 John Stillwell solved the problem, noticed the solution in Spivak's book mentioned in June, and traced the problem to a 1923 book of Kerekjarto.

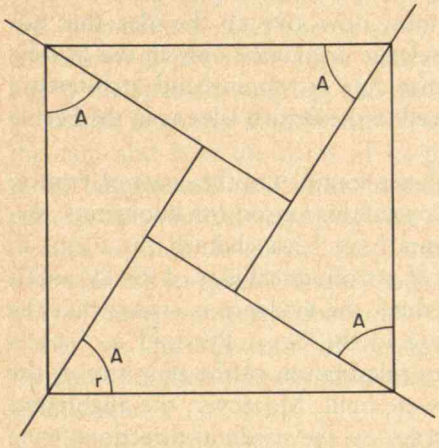
NS 5 James Shearer noticed that B should be connected to every C in the non-polar projection.

NS 6 William McGuinness has responded.

PERM 2 Morrie Gasser has responded.

Proposers' Solutions to Speed Problems

SD1 Let A be any angle between 45° and 90°:



SD2 1 = VT.

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TRAVEL

Medicine Wheels and Plains Indian Astronomy

Little is known about the nomadic tribes that once populated this continent. But it now appears that they made sophisticated observations of events in the sky, as early as two millennia ago — and ending when the Old World overran the New.

John A. Eddy
Smithsonian Astrophysical Observatory
Cambridge, Massachusetts

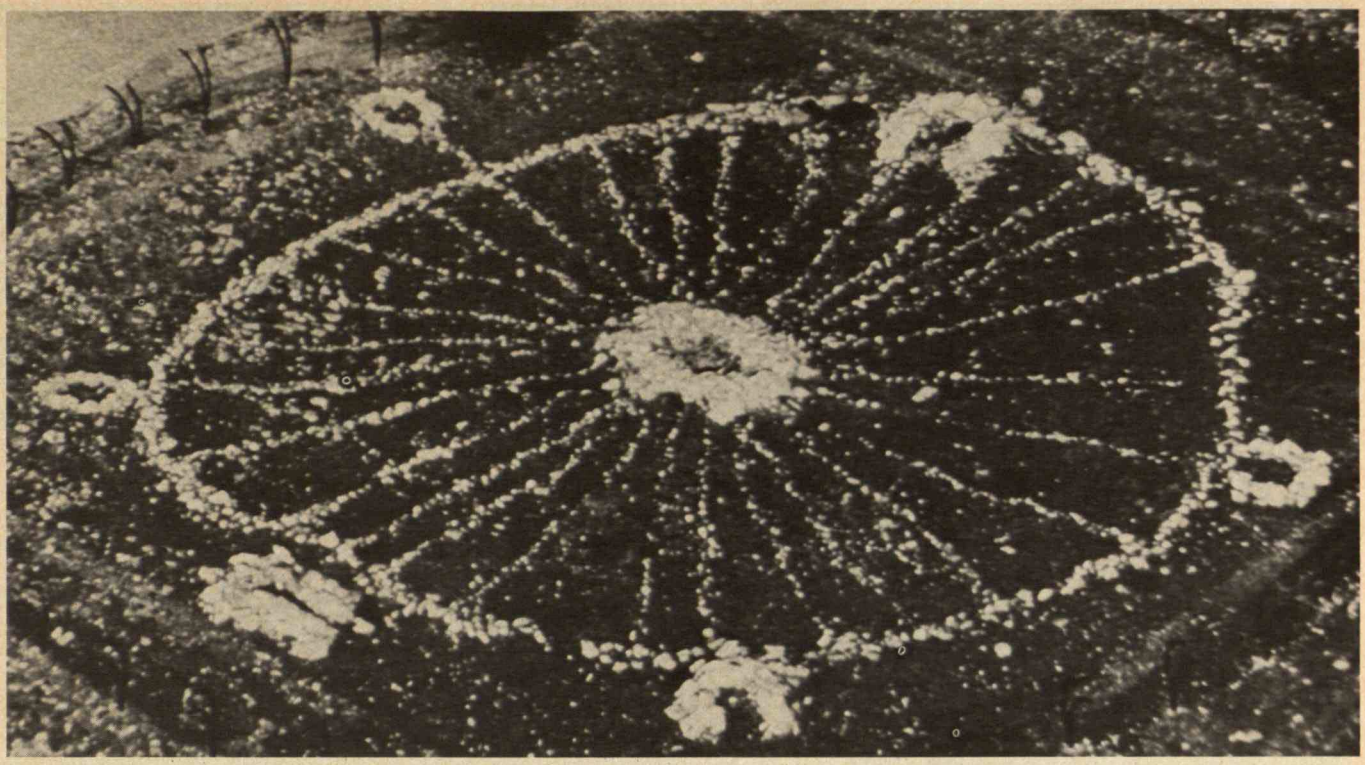
Among the thousands of organizations active in the United States of America, there is, I am told, an American Society of Witch Doctors, which holds annual meetings at a hotel in one city or another to discuss the problems and practice of that ancient art. Like other professional groups, the witch doctors are concerned about their image, and one of the items that comes up on their agenda year after year is how to get rid of the quacks.

That must be our concern, too, as we take up the question of how much the ancients knew about the sky. Among the sciences, astronomy and archaeology are surely the most speculative, for both are compelled to deal with very incomplete information. It seems obvious that the combination of the two is therefore especially fraught with danger; one must be careful about believing any of it. Yet archeoastronomy is an exhilarating field, one that is laced with the excitement of controversy and the vigor of cross-disciplinary studies. And I am convinced that in general, the important breakthroughs in science and learning are now to be found in issues that cross the stifling and rigid boundaries of our conventional disciplines.

Is archeoastronomy a field of quacks? The best known evidence that early man knew and used the sky is surely Stonehenge, in the British Isles. For more than a hundred years, the secret of its alignment with the summer solstice — that is, with the northernmost point at which the sun rises in the course of the year — has been known. Other aspects of the monument's construction are more controversial, such as the claim that it was used to predict lunar eclipses. But Stonehenge does not stand alone; there are at least 900 other structures like it, though not all so grand and megalithic, throughout the British Isles. Many of them have been studied, and by and large their alignments demonstrate an early interest in astronomy. In part by this weight of evidence a basic tenet of prehistory has now been reversed; we must now give up the idea that advanced human knowledge originated only in the Middle East. Evidently Bronze Age astronomy and architecture were fully as advanced in the British Isles as in the Fertile Crescent.

Where else is evidence found? On the coast of France, at Carnac, lines of megaliths run on for kilometers. Astronomical alignments have been claimed for them. In Egypt, the question of astronomical uses of the Pyramids still remains. But I think the evidence is strong that the hidden north passage in the Great Pyramid at Giza is aligned to the lower culmination of the pole star at the time the Pyramids were built. Moreover, the alignments of the pyramidal bases on the cardinal directions were probably laid down by astronomy. And these are but scattered examples.

In concentrating on the Old World, however, we may be examining only the dullest part of the evidence. For probably the clearest case of man's early interest in the skies comes from Central America, where astronomers were priests and priests were astronomers, and the destinies of individuals, of cities, and of nations were thought predetermined by the inexorable clockwork of the sky. Among the Classic Maya, astronomy was not so much an



The Bighorn medicine wheel, in Bighorn National Forest, west of Sheridan, Wyoming. The diameter of the wheel is about 90 feet, that of the central hub about 12 feet. Twenty-eight spokes radiate outward from the central hub, and six cairns of stone mark the wheel's periphery. (U.S. Forest Service photograph.)

intellectual adventure as a deadly serious game, one that fixed rigid rules for public and private life. It became, in effect, the basis for the highest civilization of the pre-Columbian New World.

As the jungles of Mexico and Guatemala are cleared away, we find temples and pyramids aligned to astronomical phenomena. And we read of astronomy in the stonehewn glyphs and the few codices that escaped burning by the Spanish explorers and clerics. We discover the particular attention paid by the New World's people to the sun, and how the dates of its passage through the zenith determined one of their three sacred calendars — a curious calendar 260 days long. We also read of their attention to that brightest and most beautiful planet, Venus. In the so-called Dresden Codex, a book written by Mayan hands sometime during the first millenium after Christ, we find that some of the strange-looking glyphs represent numbers that encode details of the following celestial cycle:

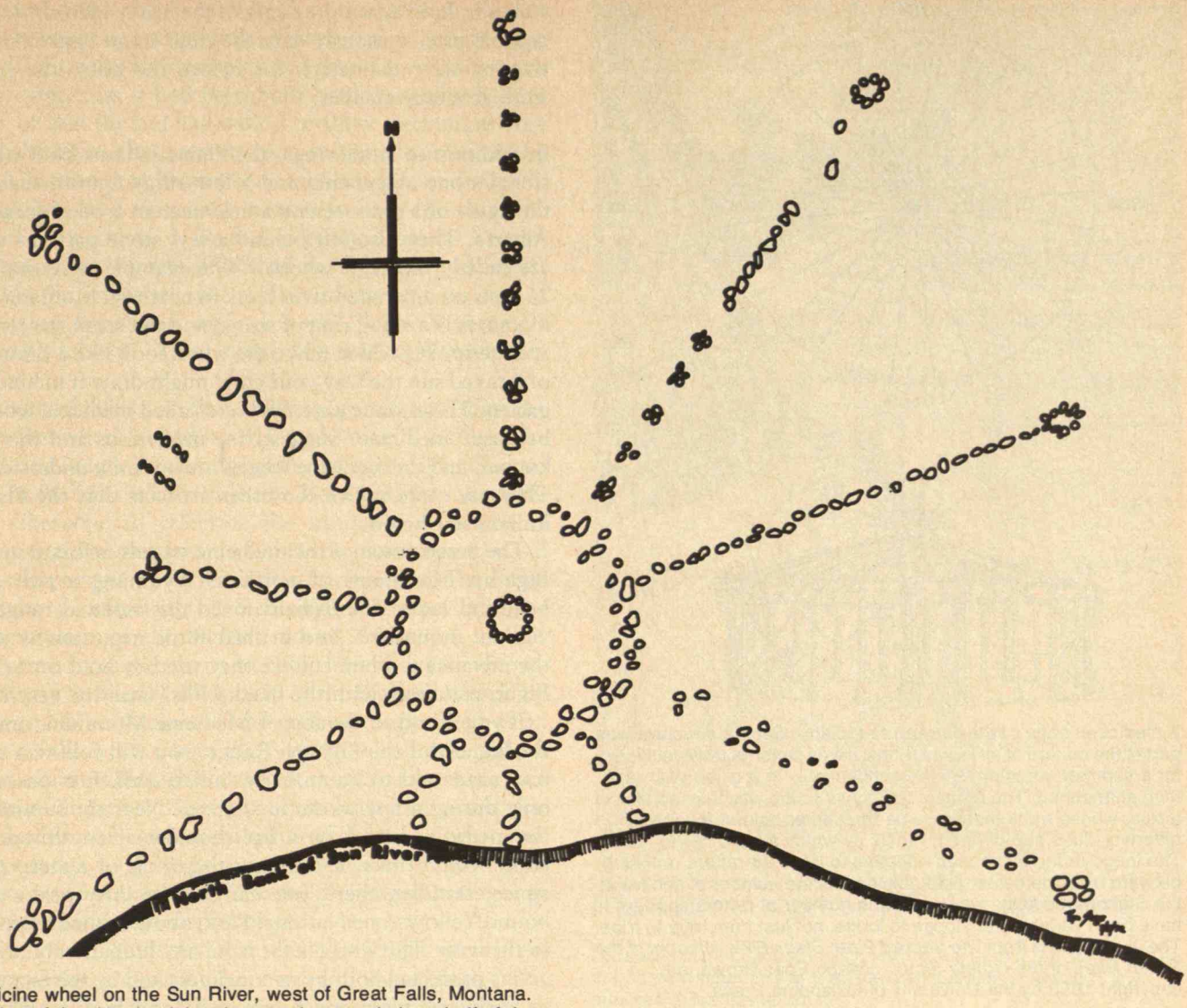
Begin at a time when Venus has its heliacal rising — that is, when it rises just ahead of the sun and thus disappears rapidly in the brightness of the morning sky. The number of days between that time and the time when it next passes too close to the sun to be seen (the time when again it will rise heliacally) is 236. The number of days until it reappears as an evening star is 90. The number of days until it disappears for a third time, now in the light of the setting sun, is 250. Finally, the number of days until it reappears just before dawn — that is, in a new heliacal rising — is eight.

These numbers, which most of us don't even know today, are all tabulated in the Dresden Codex. Their sum is 584, which is the length of the synodic period of Venus — the time required for that planet to make one apparent trip around the sun. The decoded Dresden Codex thus suggests that the Maya were very close, in about A.D. 1000, to understanding the orbit of Venus, and perhaps to making a map of the solar system. The Dresden Codex, moreover, is one of only three major books that have survived from the Mayan civilization. It is as if a great library had burned down, and only three random documents were saved, one of them containing astronomical ephemerides. What could all the others have contained? Although we shall never know, I like to think that the Mayan civilization may have been about to produce a Ptolemy or a Copernicus — one whom we didn't allow to be born. Michael Coe, the respected Mayanist at Yale University, has bemoaned the fact that Spain sent to the New World, not scientists and savants, but soldiers, who not only overlooked the amazing accomplishments in the New World of learning, but destroyed the civilization that had made them. How sad it is that we didn't give the MesoAmericans another century or two to let them advance their discoveries of the sky and perhaps create, independently, their own physical model of the cosmos. For how exciting it could have been, when the two Worlds met, to compare separate concepts of the universe: that of the Old World, which had long been obsessed with the earth, and that of the New World of America, which had always been more concerned with the sky.

The effigy figure of a man on a short-grass plain in southern Alberta. Though only a few such figures have been found, they appear to have been typical of the Plains Indians. The figures almost always are male; sometimes they are accompanied by a dog. The figure in the illustration is approximately 25 feet long.

The study of MesoAmerican astronomy has taught us much of what we know about the advanced pre-Columbian cultures of America, which in some respects were fully as advanced as any in Medieval Europe. I suspect that the continuation of this study will produce many surprises. Perhaps it will yield new clues to one of the oldest and most interesting questions of all: How did early man come to the American continents? In how many ways and at how many times? Were there important trans-Pacific or trans-Atlantic contacts? It is known that man did not evolve in the Americas; there are no great apes in the New World from which he could have done so. Accordingly, and from other evidence, it has long been believed that man arrived here rather late, during one of the most recent glaciations, when he walked dry-shod across the Bering Strait and entered the New World through an icy northern door. By possibly 20,000 years ago, he had already reached Patagonia, at the southern tip of the Americas. And by 1,000 years ago, he had achieved a surprising level of culture in MesoAmerica, with an elaborate astronomy, a well developed art, and a written language.

But why, if early man ranged from the northern to the southernmost limits of the New World, did he choose the jungles of Yucatan for his highest achievements? What a curious place for culture to flower! Why did it not blossom in California or Florida, where the living is easy, or in Cambridge, Massachusetts? Why Mexican jungles, of all places? Was there an orderly evolution there? Or might Mexico have been the locus of a significant cultural implant? Archaeologists know that the pottery, masks, toys, and other items made by Olmec and Mayan peoples are much like those made in the Orient at the same time. Moreover, astroarchaeology is now building a case that the lunar zodiac employed by the Mayans was remarkably like that used by the Chinese and Indian peoples: in both systems, the moon occupies 28 stations in its path around the sky. If a one-to-one correspondence can be es-

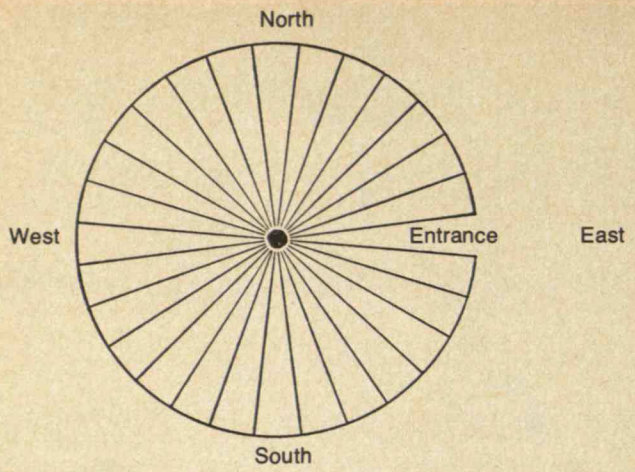


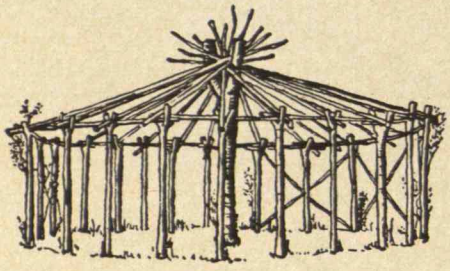
Medicine wheel on the Sun River, west of Great Falls, Montana. Erosion of the river bank has by now destroyed about half of the original structure. Still, the pattern of a medicine wheel is plain: a central ring of stone with spokes radiating outward.

tablished between the two sets of stations, that would seem strong evidence for a late cultural input from the East.

Some of the answers to the teasing questions of how learning spread in America must come from a study of the American peoples adjacent to the flowering cultures of MesoAmerica. These include the American Indians to the north of Mexico: a mélange of many apparently separate peoples, from the relatively sedentary Anasazi to the wandering Plains tribes that roamed through what is now the western United States. In part through astro-archaeology, we know that long before the time of Columbus, a Mexican influence had spread up into the American Southwest, where we find it in the architecture, the religion, and perhaps the astronomy of the Anasazi and the Hohokam. We also suspect that at one time a Mexican influence crossed the Gulf of Mexico, spread up the Mississippi, and perhaps, late in the sequence of events, led to the building of earthen temple mounds such as we now see at Cahokia near St. Louis. Earthen structures of the Mississippian Mound Builders are remarkably like those of Mexico and probably, therefore, hold astronomical secrets in their remains.

But what of the early Plains Indian? We know less about him, I think, than about any of his contemporaries, even though he was present on the plains west of the Mississippi for at least 20,000 years. We know little, for unlike the MesoAmericans, the Plains Indian had no written language; unlike the Anasazi, the Plains Indian built little; and unlike the woodland tribes of our Eastern Seaboard, whom European man studied rather closely from the time of the first explorations, the Plains Indian was first seen by Coronado in about the year 1540, and then pretty much ignored for almost 200 years. During that time, he had ample opportunity to adapt to what he had learned from the white man, including the use of the horse, which revolutionized his life. We are thus well warned not to think that the early Plains Indians were





A medicine lodge of the Cheyenne Indians. Such a structure was part of the culture of all Plains tribes; it was constructed specifically for a summer ceremony — the sundance — in a given year, and then abandoned. The heart of the construction was the sacrifice of a tree, whose trunk then became the center pole of the lodge; different tribes had different rituals by which all of this was done. The lodge in the illustration happens to have 28 rafters radiating outward from the center pole; this equals the number of spokes in the Bighorn medicine wheel, but the number of rafters appears to have been variable from lodge to lodge, not just from tribe to tribe. The illustration is from *The Sacred Pipe: Black Elk's Account of the Seven Rites of the Oglala Sioux,* Joseph Epes Brown, ed., copyright 1953 by the University of Oklahoma Press.

anything like those we see John Wayne shooting at. For one thing, the early Plains Indians travelled on foot, and their methods of hunting and living must have reflected this.

It is surprising that we know anything at all about early man on the Plains, considering how few of them there were, and over how great an area they were spread. It is commonly said that when Columbus set foot in America there were about as many Indians between the Mississippi and the Rocky Mountains as there are now people who live in my home town of Boulder, Colorado. These 50,000 to 100,000 souls were spread over an area from Texas to Canada, comprising nearly two million square miles. And most of them were always on the move.

Though the Plains Indians built little, they did leave behind perhaps five to six million stone rings, each ranging from five to twenty feet in diameter, made from local fieldstone. The rings often appear in clusters. Because they were so numerous and so common, we can assume they were utilitarian. Most of them are now taken to be the rings left where *tipis* stood, the rocks used instead of stakes to hold down the edges of the heavy hide tents. Archaeologists cautiously date the rings in an approximate way by their diameters, for before the horse the rings were generally smaller.

In addition to stone rings, the Plains Indians built occasional stone alignments and a few effigy figures, such as the figure of a man seen on a field near an eroded gorge in Alberta. They also left behind a few stone patterns that are called "medicine wheels." The example seen on page 21 rests on an eroded river bank in northern Montana. At its center is a small ring of stone, and out from the center radiate spokes which make the wheel look like a drawing of a rayed sun the way your child might draw it in kindergarten. These stone patterns were called medicine wheels because "medicine" suggests the mysterious and the unknown, and the medicine wheels are not fully understood. They are quite unlike the other artifacts that the Plains Indians left behind.

The best known of the medicine wheels is found in the Bighorn Mountains of northern Wyoming, a rich and beautiful land. The Indians loved this isolated range of verdant mountains, and in their futile negotiations with the advancing white culture they tried to hold on to the Bighorns (along with the Black Hills) until the very last.

If you climb to the top of Medicine Mountain, one of the highest of the Bighorn Range, you will follow a narrow road said to be an early Indian trail. It is passable only during a few weeks in summer. Near the summit is the medicine wheel, on a flat shoulder at an altitude of about 10,000 feet. It lies near the brink of a steep precipice; standing there, one can see the lofty peaks that bound Yellowstone National Park, about a hundred miles to the west. The wheel is far from any human habitation, and is protected both by its loneliness and by the fact that its rocks are plain and heavy and don't look worth the trouble of carrying them off. The Forest Service has also placed a fence around it.

I think that almost every visitor to the medicine wheel is at first disappointed, for it is a crude structure, made from native sandstone. It looks like the sort of thing that a few people could build in an easy day. The wheel includes a central hub — a pile of rocks about 12 feet across and several feet high, hollowed out in the middle. From it radiate 28 spokes. They end at a ring about 90 feet in diameter — not a perfect circle at all, but rather elliptical in shape. At intervals along the periphery of the wheel are six cairns of rock. They are curiously placed: some are on the outer edge of the ring; some are inside the circle; one is entirely outside the ring, at the end of an extended spoke. The peripheral cairns are all hollowed out into U-shaped rock piles. Some of them open one way, some of them another.

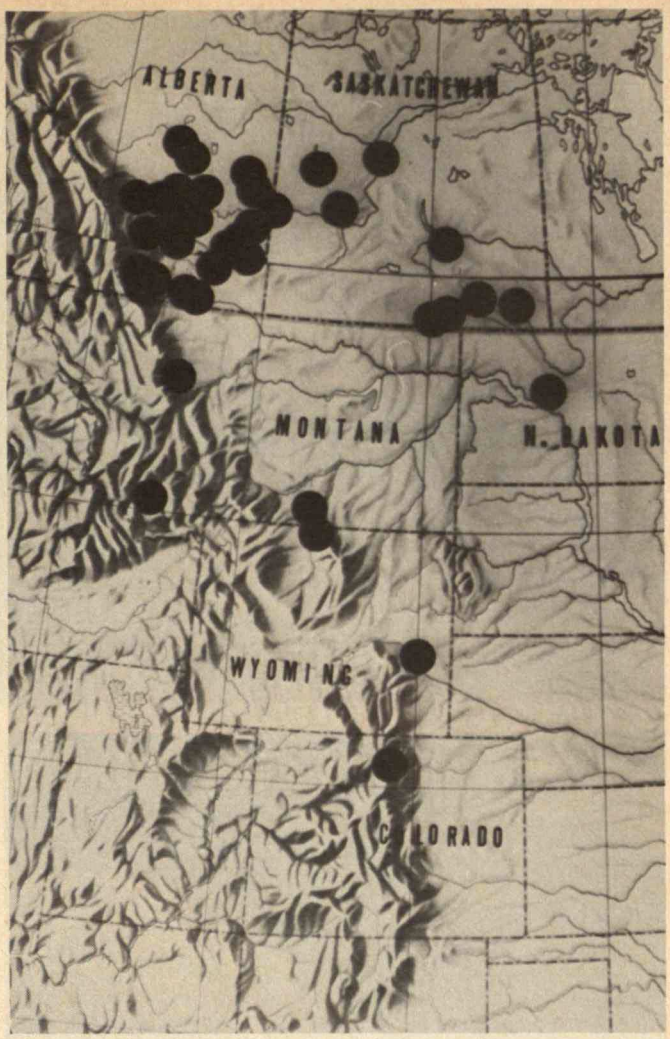
The Bighorn medicine wheel was found in the late 1880s by early prospectors. Its existence was soon reported to archaeologists, who went to see it in the early years of this century. They asked the local Indians to tell them what they knew about the wheel. At first, these informants — the Crow, the Sioux, the Cheyenne, the Arapaho, and the Shoshone — said only that they had

heard of it, but that they didn't know what it was for, or even where it was. Gradually, though, a few legends came out. The Crow, for example, said that it was there when they came, that it had been built by people who had no iron, or that the sun had built it to show the Indians how to make *tipis*. These stories were sustained somewhat by the Chambers of Commerce in Sheridan and Lovell, Wyoming, who may have wanted to keep the medicine wheel mysterious. I have a clipping from a Casper, Wyoming, newspaper published in 1941 that proclaims: "Solve the riddle of this ancient monument on top of Medicine Mountain and you will solve Wyoming's biggest problem." How simple life was in Wyoming in 1941!

Archaeologists of the 1920s pointed out that the medicine wheel looked much like the plan of a Cheyenne medicine lodge. We are compelled to agree. The illustration at the left shows a medicine lodge built by the northern Cheyenne to celebrate the sundance ceremony, a summer ritual that was probably the most common and most important of Plains Indian ceremonies. The lodge includes a central post which might correspond to the central cairn of the Bighorn wheel. Moreover, in this Cheyenne example, there are 28 rafters that radiate outward, much like the 28 spokes of the Bighorn wheel. Finally, in some versions of the medicine lodge there is an altar to the west, where the Bighorn wheel does indeed have a cairn, although somewhat displaced from the true compass direction. These correspondences suggested that the medicine wheel was a replica of the medicine or sundance lodge — perhaps a two-dimensional replica built where wood was scarce above the timberline. It may thus have marked a ceremonial place.

We know, however, that the last refuge of the anthropologist is always in ceremony: if something cannot be explained in any other way, it is usually fairly safe to attribute it to that. I wondered if the medicine wheel could have had a more practical use, a use tied to the sky, which is such a dominant feature of the landscape of the plains. It struck me first that the number of spokes in the medicine lodge and in the Bighorn medicine wheel was close to the number of days in a lunar month. In addition, the positions of two of the Bighorn wheel's cairns, as well as their symmetry about a north-south line, made me wonder if those structures might have been used with the central cairn to mark the rising of the sun at certain distinctive times of the year. The most easily marked of these is the summer solstice, about June 21, which was, for some, the time of the sundance ceremony. The Bighorn medicine wheel is well placed for a primitive observatory, with good horizons all the way around it.

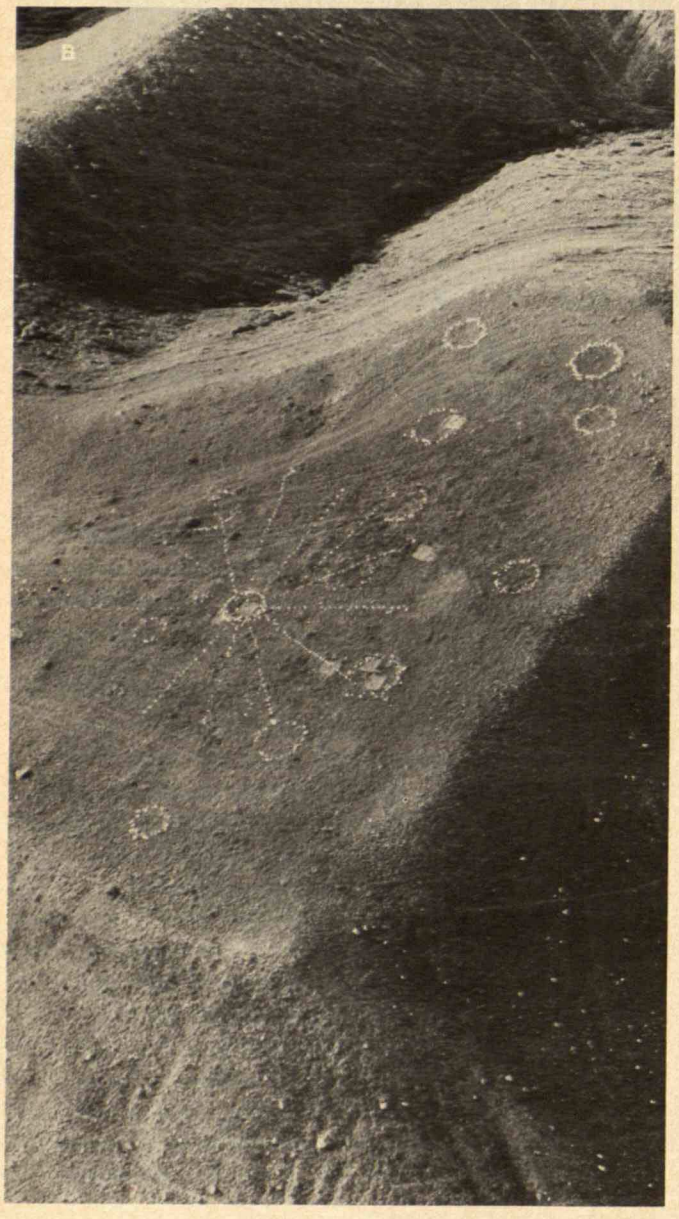
Several years ago, I set out with my family to test this possibility. In late June, just before solstice, we tried to go to the medicine wheel to watch the sunrise. We failed, for the road was blocked several miles below Medicine Mountain by heavy snow that had fallen the night before. If this were typical of Junes in the past, it seemed unlikely that any Indian would have used the wheel to mark the summer solstice. However, snow comes and goes rapidly in the mountains, and the very next day, on June 20, we



Locations of medicine wheels known to the author. All of them lie at the eastern boundary of the Rocky Mountains or within a few hundred miles farther east.

were able to reach the site. We found the wheel free of snow; and in fact, considering that mountain peaks are constantly scoured by winds, I suspect that much of the medicine wheel may have been free of snow on the previous day as well. The whisking action of mountaintop winds may have been a reason why the wheel was built there, and in any case the cairns would have poked through any moderate layer of snow.

Our effort to find associations between the sun and the medicine wheel proved to be successful; for standing at the rather distinctive cairn that lies outside the ring, and sighting from its center through the center of the hub-like cairn, as best I could fix those points, I found that I was looking at the distinctive point on the horizon where the sun rises on the morning of the summer solstice — the point where the sun rises farthest north of east in the course of a year. This was confirmed by transit measurements, and by observation of the sunrise in subsequent years. I also found that when I stood at a second cairn and sighted across the central hub, I saw the point where the sun set on the same day. Thus, if the builders of the



Four examples show the variety of structures subsumed under the name "medicine wheel." The wheel labelled "A" is a primitive structure, perhaps an early medicine wheel, in Rocky Mountain National Park, Colorado. Wheel "B" is elaborate. It lies on the bank of the South Saskatchewan River near Medicine Hat, Alberta. Wheel "C" is at Fort Smith, on the Crow Reservation in southern Montana. A small circle and five radiating spokes can be dimly seen; they splay across the lower part of the photograph. Wheel "D", near Minton, Saskatchewan, has the shape of a turtle. Bushes have grown on the central cairn.

medicine wheel wanted to mark this distinctive day of the year, they had built in a second way to do so: if the dawn were cloudy they could use the sunset. For on the day of summer solstice the sun sets farthest north of west.

I think it unlikely that the solar alignments involving three cairns of the Bighorn medicine wheel were accidental. However, they leave a number of other cairns to be explained. Were they also astronomical markers? One must be very careful in trying to establish this, for there are many objects in the sky. Given, therefore, a small number of cairns but a great number of stars and planets, not to mention the varying positions of the moon and sun, one is fairly likely to come up with something. I first made calculations to see if the sunrise at winter solstice was marked. It was not, which is not surprising, because the site is accessible only in late spring and early summer. I also checked for markings of the moon's wanderings. They, too, were absent. I then began to look for markings of the stars.

The illustration on page 31 is a time exposure of stars rising before dawn at the medicine wheel (the cairns have been illuminated by flash). The dimmer stars, of course, are the thinner lines in the photograph. Notice that these star trails do not begin until the stars are appreciably above the horizon. The brighter stars, however, can be seen far lower in the sky. I found that one of the brightest stars in the sky rises roughly in line with two of the non-solar cairns of the Bighorn wheel. It is Aldebaran, the brightest star in the constellation Taurus. And from one of the cairns used to observe Aldebaran, two other cairns line up with two other very bright stars. One is Rigel, the brightest star in Orion. The other is Sirius, the brightest star in the sky.

Now all of these stars are situated in the area of the sky in which the sun spends midsummer. It follows that all of them will rise near dawn at the time of the summer solstice; and accordingly it seems reasonable that they might have been noted or used by people who were watching for a summer dawn on top of Medicine Mountain. Moreover, the heliacal rising of one of them, Aldebaran, turns out to be exactly right to mark the summer solstice at the time the wheel was built — determined by archaeologists to be 200 to 400 years ago. It is the only star in the sky that could have served this purpose.

How would the sky have looked if you had stood at the top of Medicine Mountain before dawn on the day of summer solstice several centuries ago? About an hour before dawn, Aldebaran would rise. The pre-dawn sky would already be blue, and all the dim stars would be gone. Indeed, the coming sun would be brightening the sky so rapidly that on this particular day Aldebaran would flash out like a beacon near the horizon, lasting only a matter of minutes before disappearing in the pre-dawn glare. That phenomenon would make this day a distinctive one, for on the previous day Aldebaran would not have been seen at all (the sun's light would have masked it) and on the day after it would have persisted far longer. In short, watching for Aldebaran's flash at dawn would have given a precise indication of the solstice, accurate to within a day or two.

And after that? Each morning after the summer solstice, Aldebaran would climb farther into the sky before the light of dawn would extinguish it. At dawn 28 days after solstice, the bright star Rigel would appear, as Aldebaran had done, but above a second line of cairns. It is interesting that there are 28 spokes in the medicine wheel, but one cannot know whether this connection is fortuitous.

Rigel, like Aldebaran before it, would flash briefly just above the horizon on the first day of its appearance, and on subsequent days would rise higher into the sky before extinction by the light of the morning sun. Twenty-eight days after Rigel's first appearance, Sirius would rise above the third of the cairn alignments that I was able to find. Sirius, too, would flash briefly on the first day of its appearance.

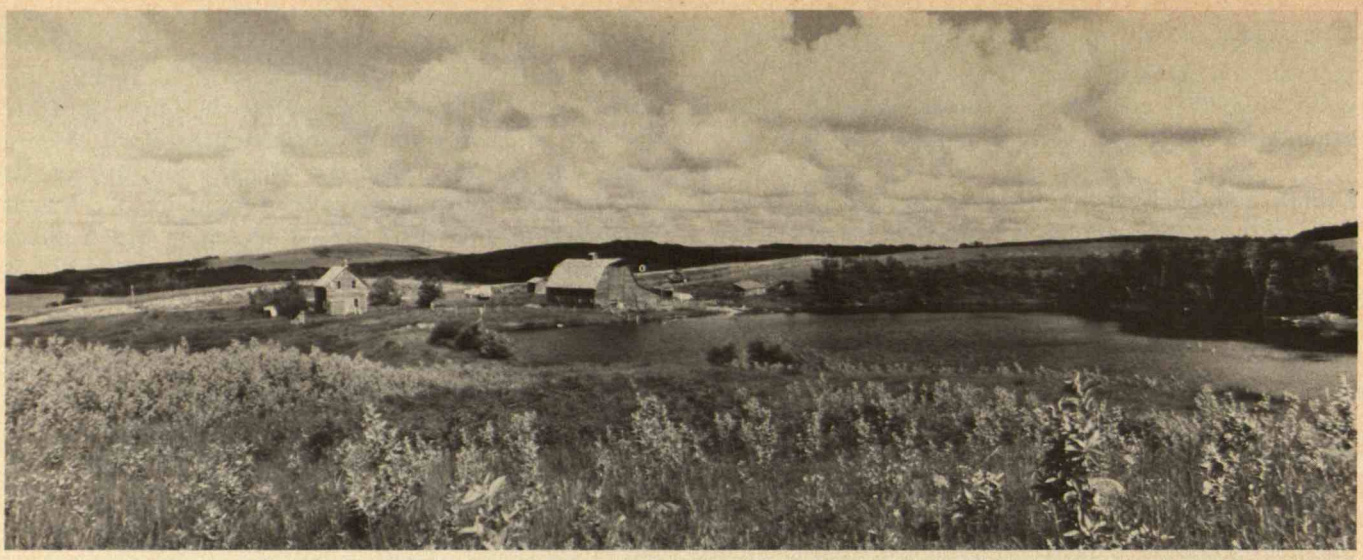
The overall idea, then, is as follows: Aldebaran's brief flashing in the sky — that is, its heliacal rising — would warn you that the day of summer solstice had arrived. An hour later, the location of the sunrise itself would confirm this. So would the sunset that night. One month later, Rigel would appear in the morning sky; and one month after that, Sirius. These latter events may simply have marked off the time during which the mountain could be occupied. The rising of Sirius would have been a good sign to leave Medicine Mountain because winter was coming.

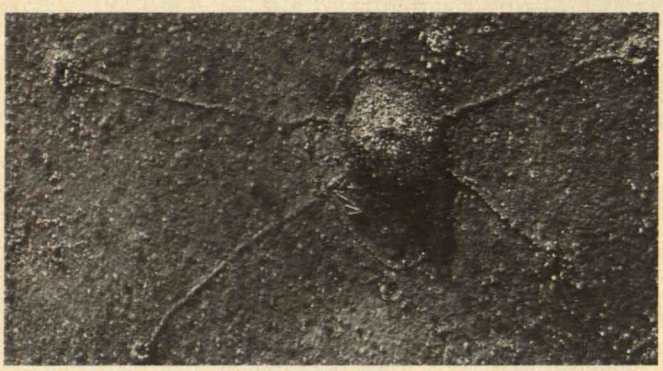
If all this is true, it suggests that the medicine wheel may have been a sacred place, known, perhaps, to a few, who used it as a way to mark off an accurate calendar, or more prosaically, to signal the solstice. That date may have been needed to mark the time of the sundance ceremony. The resemblance of the medicine wheel to a sundance lodge might then be valid, but in the opposite way than was previously supposed: the sundance lodge may have been modelled after a medicine wheel, rather than the reverse.

Could the solar and stellar alignments at Medicine Mountain be accidental? Calculations of the mathematical probability of chance alignment could be given, but I have never believed very much in that approach. It is probably better to examine other medicine wheels to see if any of them show the same alignments. The map on page 23 shows the locations of medicine wheel sites known to me; they are found along the eastern boundary of the Rocky Mountains, in a broad sweep that stretches several hundred miles to the east over the Great Plains. Most of them lie north of the Bighorn wheel; many lie in Canada.

Photograph "C" at the left shows a medicine wheel on a hillside at Fort Smith, Montana, on the present-day Crow Reservation, about 60 miles north of the Bighorn wheel. The Fort Smith wheel is a small circle with five crooked spokes that droop down over a hillside; I suspect that some of the bending is due to soil creep on the hillside, but perhaps they were always bent. The longest of the spokes is aligned to the rising of the sun at summer solstice.

Photograph "A" at the left is of a possible primitive





This page: The medicine wheel at Moose Mountain, in southeastern Saskatchewan. The upper photograph shows the surrounding area. All of the modest ridge spanning the horizon is the mountain in question — hardly a moose and indeed hardly a mountain. Toward the left of that ridge is a small bump, the site of the wheel itself, shown in an aerial view at the left. Five spokes with cairns at their ends are easily visible, though one is shorter than the others. A sixth cairn is far harder to see. In a sense, however, it is redundant, for it marks the direction to sunset on the day of summer solstice, and a far more prominent spoke marks the direction to sunrise on that day.

Opposite page: A comparison of the Bighorn (left) and Moose Mountain Medicine Wheels. The six cairns on each can be placed into one-to-one correspondence, almost as if the same building plan had been used for both.

medicine wheel in Colorado's Rocky Mountain National Park, at an elevation of about 11,600 feet, near an old trail attributed to Ute Indians. This wheel comprises only a central cairn and two crude spokes. One of them is aligned to the summer solstice sunrise.

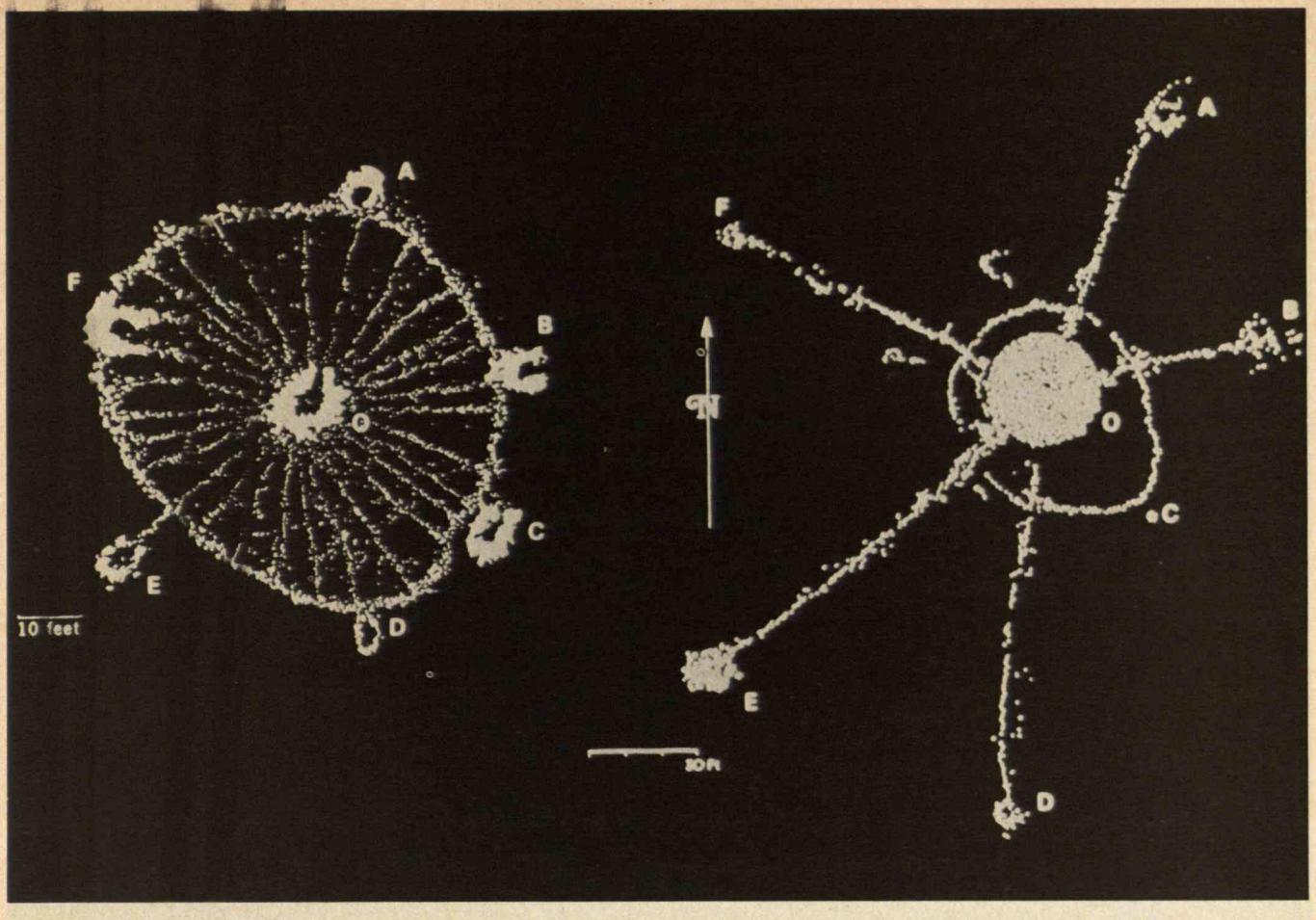
Most medicine wheels are found in Canada, in the prairie provinces of Alberta and Saskatchewan. With a grant from the National Geographic Society, and in association with archaeologist Dick Forbis of the University of Calgary and Tom and Alice Kehoe of Milwaukee, I was able to make aerial surveys and ground surveys of about 20 of them. We found that they are very different, one from another; I think they were built at different times, by different people, for different purposes.

Some of the medicine wheels are simple piles of rock. Others are slightly more elaborate: the large central cairn is sometimes surrounded by circles and often by what looks like a gateway. We found that these gateways and other simple features usually point to nothing special in the sky, but rather to something on the ground — namely another medicine wheel, sometimes ten miles away, sometimes 20 or 30. We suspect that some of these simple wheels could have served as landmarks in an otherwise unmarked terrain, for the rolling land around these wheels looks so much like an ocean that it makes one seasick to fly over it. There are few trees or other landmarks.

Still other medicine wheels have very elaborate patterns, much like the Bighorn wheel. The one shown in photo "B" on page 24, seen from the air in Alberta along the banks of the South Saskatchewan River, is about 200 feet across. It has a central circle that looks like it might have been a *tipi* ring, and spokes that radiate outward and end in small, knoblike cairns.

Finally, some medicine wheels are in the shape of effigies. The one shown in photo "D" on page 24 is in Saskatchewan near Minton, and takes the form of a turtle. The turtle's back is the central cairn of the wheel. Bushes have grown on it, giving the cairn a furry appearance. The body of the turtle includes four legs, a head (with two ears!) and a tail. The Kehoes found that the axis of the turtle points to sunrise at summer solstice.

If we limited our attention to only those wheels that are distinctive, and not just heaps of rock, we almost always found associations with objects in the sky. In this regard, the most interesting site of all is situated atop Moose Mountain, in the rolling prairie of Saskatchewan, southeast of Regina. The photographs just above show the site. Moose Mountain is really a low ridge, not a mountain at all, and there are no moose living there. I think the ridge resembles the back of a moose from a great distance. At the very end of the ridge, just over the abandoned farmhouse in the photograph, is the highest point, the final bump, on Moose Mountain. It is a place that is associated in Indian legend with the sky: there are stories about an Indian maiden who walked along the ridge of

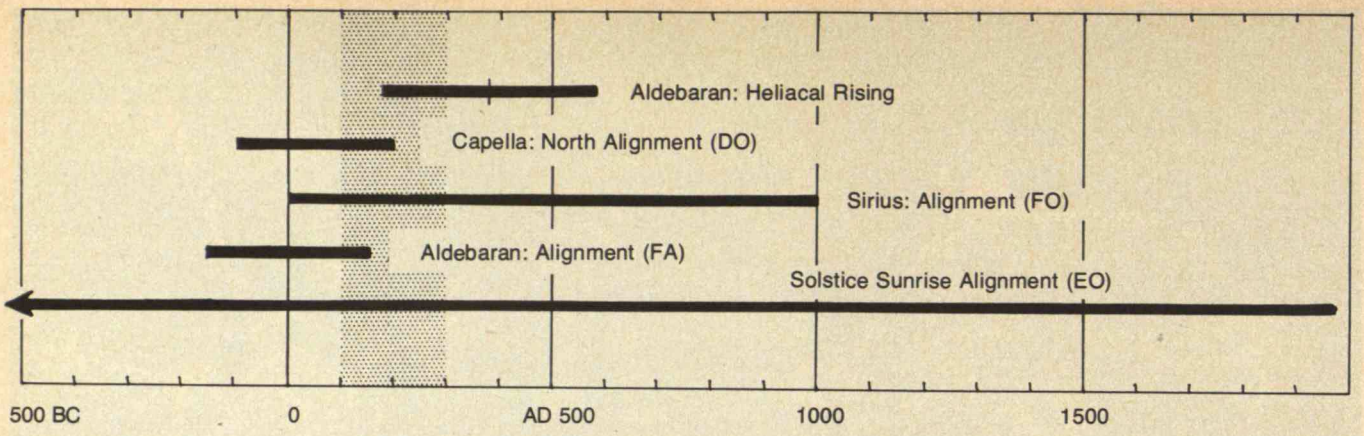


Moose Mountain, fell in love with the sky, and upon reaching the bump was carried away by the sun. The medicine wheel is found at that place. It has a large central cairn, as do almost all of the Canada wheels. Perhaps the cairn was built up gradually, as passers-by picked up local rock and threw it on the pile. The present total is about 80 tons, all of it picked up nearby. The wheel also has five spokes that give it an overall diameter about twice as large as that of the Bighorn wheel. There is a sixth spoke that is somewhat shorter. All of the spokes are primitive and rudimentary; all have sunk into the ground with age. At the end of each spoke is a cairn.

I have not yet said that recent archaeological excavation of the Bighorn wheel has shown that its central cairn was built first, and the 28 spokes and rim were added later. This made us wonder if the Moose Mountain wheel in Saskatchewan might be an early version of the Bighorn wheel: that is to say, if the Moose Mountain wheel might be the cairns without the later decoration. This seems especially possible when the two wheels are directly compared. The illustration on this page does so. On the left is the Bighorn wheel; on the right, the wheel at Moose Mountain. Assuming that the spokes and circumferential ring were late additions at Medicine Mountain, and that the structure first comprised only a central and outlying cairns, the correspondence is very good. For cairn E, which was the sunrise cairn at Medicine Mountain, there is a cairn E at Moose Mountain. For cairn F, there is a similar match, and so on. Not only are the cairns correct in number, they are also all placed at similar relative positions. I think the two wheels could almost have been built from the same set of plans.

We wanted to test this similarity by watching a summer solstice sunrise from the end of the long spoke at Moose Mountain — the spoke corresponding to the solstice cairn at the Bighorn wheel. But the sky was cloudy on that day during our visit; it was impossible to take photographs that would convince anyone that when the sun rose, it did so at the right point. We convinced *ourselves,* however, by some surveying and calculating: the sunrise proved to be off the line of the long spoke by only about half a degree, which is impressive, considering that our uncertainty in fixing the center of the cairns is greater than that.

The other cairns, which at the Bighorn wheel were aligned to three bright stars, proved at Moose Mountain to be aligned to the same three objects: Aldebaran and Rigel and Sirius rose in the fashion described earlier in this article — provided one assumed that the Moose Mountain wheel was built much earlier than the Bighorn wheel. For the stars in the sky precess — that is, they move with the wobble of the earth — and thus the places and times at which they rise change with the years. In the region of the sky that here concerns us, the change has been fairly great. In order for the cairn alignments to match the rising points of Aldebaran, Rigel, and Sirius, I



The most probable time of use of the Moose Mountain medicine wheel, based on assumed astronomical alignments. The first bar on the chart shows the span of time during which the rising of the star Aldebaran occurred heliacally — that is to say, with the sun. The second bar shows the time of an astronomical phenomenon not discussed in the text. Consider that the Moose Mountain wheel has a spoke directed northward. The author reasoned that north could be determined by finding a star whose circle around the north celestial pole in the course of a night caused it to touch the horizon; the point of that tangency would be due north of the observer. Such a star, it turned out, was Capella; the second bar thus shows the time during which this tangency occurred each night. The third bar in the chart shows the time during which the rising of the star Sirius occurred in alignment with the spoke marked FO in the illustration on page 27. The fourth bar shows the time when Aldebaran rose in alignment with the spoke marked FA. The final bar shows the time when the sun rose in alignment with the spoke marked EO on the day of summer solstice. This last is no test of when the wheel was used: the sun still rises at that direction on solstice day. As the chart's shaded area shows, all of the data combine to suggest that the wheel most probably was used almost 2,000 years ago.

had to hypothesize that the Moose Mountain wheel was built not in 1600 or 1700 A.D., as the Bighorn wheel presumably was, but much earlier than that: roughly at the time of Christ. The illustration on this page shows some details of the calculation. One bar shows the approximate of time when Aldebaran rose heliacally: this datum suggests that the Moose Mountain wheel was most likely used between 100 and 500 A.D. The direction of Aldebaran's rise, which is a separate and independent test, gives roughly the same date. Another bar shows the time at which the Sirius alignment would hold true; Sirius moves very slightly, and thus fails to be a good test. Still another bar shows the Rigel alignment, and suggests a time ranging between 200 B.C. and 100 A.D. As for the solstice alignment, the sun moves so slowly that its travels do not help us in estimating a date of use.

Relying upon the data shown in the illustration, I went out on a limb and announced that the astronomical alignments indicated that the Moose Mountain wheel was about 2,000 years old. I don't think that Tom or Alice Kehoe believed me. Nor was I very sure myself.

Then, last January, I got an excited telephone call from Tom Kehoe. In the summer of 1976 the Kehoes had made further studies at the site. Specifically, they had excavated a part of the central cairn, cutting out a wedge so as not to destroy the structure. At the very bottom of the cairn they had found a flat stone floor; they felt sure they were down to the original construction. Under that, they found charcoal; apparently the ground had been burned off before construction started. There was enough charcoal at the site to permit a radio-carbon dating. The result, Tom reported, was that the fire had burned 2,600 years ago, plus or minus 250 years! That seems close enough to support the astronomical dating of the site, and proves that sometimes we astronomers are lucky.

More important, the radio-carbon dating lends credence to the alignments at the Bighorn wheel and other sites. The Indians of the Plains, that people about whom we know so little, seem to have known more about the sky than we may have thought. Yet if we ask Plains Indians today about the sun or stars, or if we examine the oral depositions taken from them during the last century, we find very little, if anything, about practical astronomy. I think it had all disappeared, long before we asked. Practical solstice marking, using sun and stars, had been in Plains lore a long time. For 2,000 years, if we are to believe the Bighorn and Moose Mountain stones, the Plains Indians used the same stars in the same way; yet by the time of the last century it seems to have been all forgotten. With the coming of the white man and his horses and his calendar and his ways, a pure and primitive natural astronomy may have been knowledge no longer needed. How fragile is learning, without the written word!

For further reading:

"Astronomical Alignment of the Bighorn Medicine Wheel," by John A. Eddy, *Science* **184,** 1035-1043 (1974).

"Mystery of the Medicine Wheels," by John A. Eddy, *National Geographic Magazine* **151** (1), 140-146 (1977).

Native American Astronomy, Anthony Aveni, editor, University of Texas Press, 1977.

In Search of Ancient Astronomies, Edwin C. Krupp, editor, Doubleday and Co., New York, 1977.

John A. Eddy is a Senior Scientist on the staff of the High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado. He is also an Adjoint Professor at the University of Colorado. Through 1977 and 1978, he is as well a Langley-Abbot Visiting Fellow at the Center for Astrophysics in Cambridge, Massachusetts. His interests are in archaeoastronomy, the history of astronomy, the astronomy of the American Indians, and the relation of the sun to the climate of the earth.

Celestial risings before dawn at the Bighorn medicine wheel. The photograph is a time exposure; two cairns of the wheel itself have been illuminated by flash. Note that the trajectories traced by dimmer stars tend to become visible only at fairly great heights in the sky — not at all near the horizon. But one object, brighter than the others, is sufficiently bright so that it becomes visible far lower. That object is the planet Venus — not a star. It happened to rise in alignment with the cairns at the time the photograph was taken, and serves to illustrate the sort of horizon phenomenon to which some of the cairns may have been aligned. (© National Geographic Society; photo by Thomas Hooper)

Pictographs and Petroglyphs of the Southwest Indians

John C. Brandt
N.A.S.A.

It has long been known that the Chinese observed a supernova in 1054 A.D. and recorded the event. Perhaps the Indians of the American Southwest did so as well.

Some years ago, a group of professional astronomers, including myself, became interested in a nebula in the southern sky, the so-called Gum Nebula. It is a large object, presumably a cloud of debris left behind by a violent stellar explosion of the type called a supernova. In fact, it is known that among the debris composing the Gum Nebula is a pulsar, a pulsing source of radiation, believed to be the rotating, extremely dense core of the star that exploded.

We could guess the age of the Gum Nebula because the spin rate of the pulsar is slowly decreasing. The age came out to be eleven thousand years. That places the time the supernova explosion was visible from the southern hemisphere of the earth at roughly 9000 B.C., and recent archaeological work in the southern hemisphere suggests that people lived there long before that time. Now if the supernova that produced the Gum Nebula was as bright as we think supernovas ought to be, and if the exploding star was at the distance from earth calculated for the nebula that now remains, the explosion should have produced a burst of light in the sky fully as bright as the quarter moon. Moreover, the burst should have lasted at least several days, and then grown dimmer over a period of many weeks. Surely even very primitive cultures, faced with two moons in the sky, would have considered this an unusual event. Perhaps somewhere on a stone wall they would have made some record in commemoration. We couldn't know what the record would look like, of course, but we felt we had a scientific duty to perform, so we wrote a paper which was published in *Archaeology*, asking that archaeologists keep the Gum Nebula supernova in mind when conducting research in the southern hemisphere.

We truly believed that discharging our professional obligation in this fashion would be the end of the matter. After all, the journal *Archaeology* was sufficiently obscure for astronomers so that none of our colleagues would snicker at us for our unseemly bit of moonlighting. But in one of those things that happen for curious reasons, *Time* magazine thought that our story was newsworthy. They published a piece on it in March of 1972.

Time had no photograph of a "Gum-Nebula pictograph," nor did anyone else. Instead, *Time* used a picture taken by William Miller, who is now retired but used to be the professional photographer at the Hale Observatories. Bill is an amateur archaeologist; the photograph is of a cave painting in northern Arizona, thought to record the supernova explosion of 1054 A.D., the explosion that created the Crab Nebula. Of course, records of a supernova explosion in 1054 A.D. have no direct bearing upon our speculations about records of a supernova explosion that occurred 10,000 years earlier. Still, we thought, the *Time* magazine article won't end our careers.

About four months after the *Time* article appeared, we received a letter from Muriel Kennedy, the wife of the then superintendent of Lava Beds National Monument in northern California. She wrote that the illustration reminded her of a painting in a cave at the monument. I was travelling to California anyway, so I made a sidetrip. The cave painting was marvelous. I was hooked on archeoastronomy, and have been in the business ever since.

The hypothesis I wish to explore in this article is that western North America (primarily the western United States), contains several images representing the Crab Nebula supernova, visible on earth in 1054 A.D. We know it was visible in that year because Japanese and Chinese literature, specifically the records of the Sung Dynasty, tell us so. Moreover, a comparison of Crab Nebula photographs taken on different dates shows that the nebula is expanding at a rate suggesting an age of about 900 years.

Were the Indians of the Southwest sufficiently astute, and sufficiently interested in celestial phenomena, so that they might have recorded the explosion? I will claim that they were and that they did so. All the evidence is circumstantial, of course, but if the circumstantial evidence is denied, then one must postulate instead a large number of rather strange coincidences.

To begin with, a definition: the archeoastronomers considering evidence relating to supernovae must in general deal with two kinds of records. The first of these, called a pictograph, is an image made on rock with paint or chalk or a rock that mimics chalk. The second, called a petroglyph, is an image incised in rock by a chisel or an object used as a chisel. It has been suggested that the word pictogram ought to be used for both records, but this idea has not yet caught on.

Now the illustration at the right shows a petroglyph

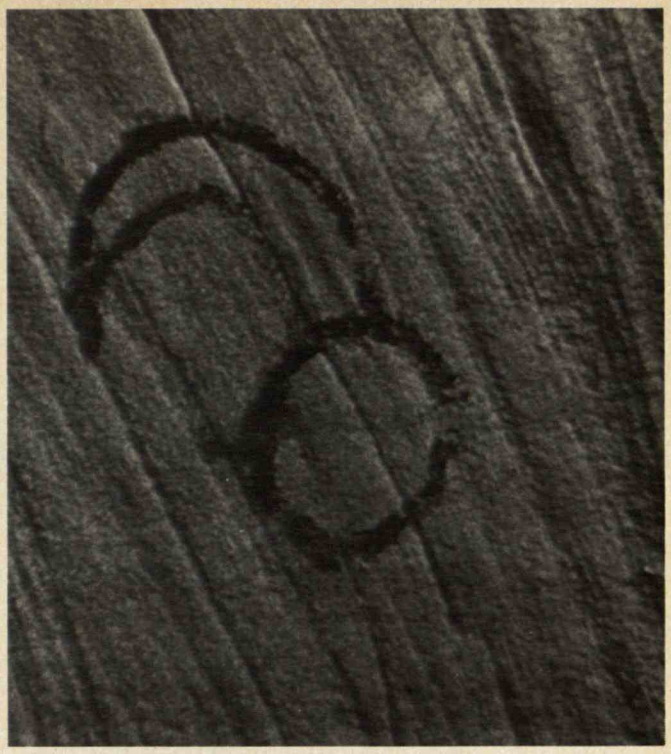
and a pictograph that Bill Miller first discussed in print in 1955. Both records include a crescent and a circle. The circle is often used as a representation of the sun or some other bright object; the obvious candidate for the crescent is the moon. One is therefore encouraged to ask: What did the sky look like in 1054? Was there a bright object near the crescent moon? Was it the supernova?

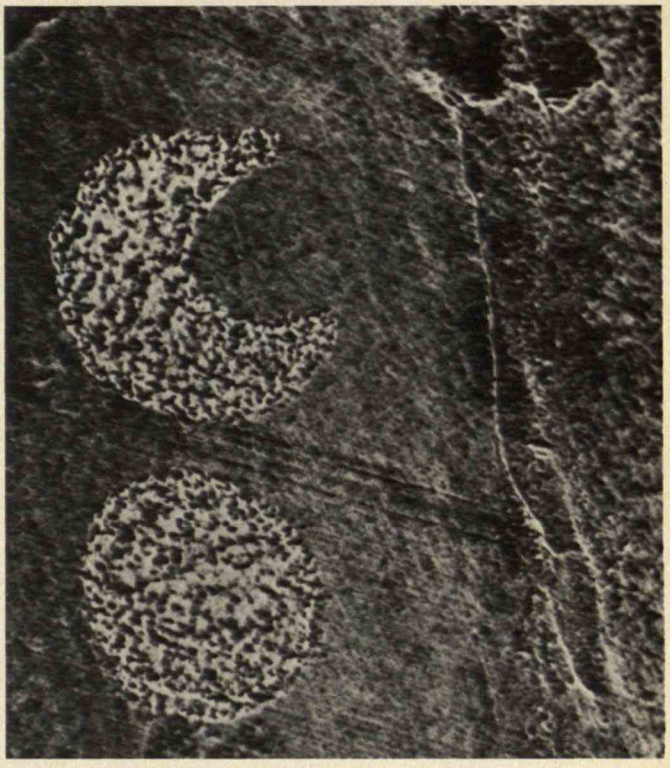
One of our collaborators works at the U.S. Naval Observatory in Washington, D.C., and thus has access to many computer programs involving celestial mechanics. One of them is called "Ancient Moon," and gives a precise determination of the moon's location with respect to the celestial sphere (the background of stars) at any given time on any given date. It turns out that at the time of the supernova the moon wasn't near any of the bright planets. It *was* near the sun, however. Still, the moon is near the sun very often, and I doubt that anybody would have bothered to commemorate an event like that. Finally, as we discovered with pleasure, it was also near the supernova. The diagram on page 36 shows the relevant portion of the sky on July 5, 1054 A.D., the approximate date of maximum brightness for the supernova, as determined by the Chinese records. The coordinates are those typical for astronomy: right ascension (the celestial equivalent of longitude) along the horizontal axis and declination (celestial latitude) along the vertical. The Crab Nebula (or the supernova that produced it) appears at the lower right-hand corner of the field. The position of the moon is shown hour by hour. Note that the moon is a crescent on July 5, 1054 A.D.

Several other circumstances mitigate in favor of the interpretation we have given to the symbols. First, the Chinese and Japanese records of the Crab Nebula supernova suggest that the supernova was about five times brighter than the evening or morning star — the planet Venus in the evening or morning sky. In short, it was extremely bright. Anyone who was accustomed to looking at the sky would certainly have noticed it.

Second, the moon would have been seen in close proximity to the supernova only in western North America. As the diagram shows, this proximity occurs at moonrise. But by the time moonrise had come in China, the moon would have moved four or five degrees in the sky — that is to say, it would have risen in a position different by eight to ten lunar diameters. This is off the diagram, and well away from the supernova. Now the Chinese had a well-developed positional astronomy in the eleventh century; they referred, for example, to a star near the supernova which we call Zeta Tauri. If the supernova and the moon had been very close to each other, the Chinese would have mentioned this in their description. They did not; and in fact records linking the supernova to the moon only appear, to the best of our knowledge, in western North America, the only place in which the configuration was visible.

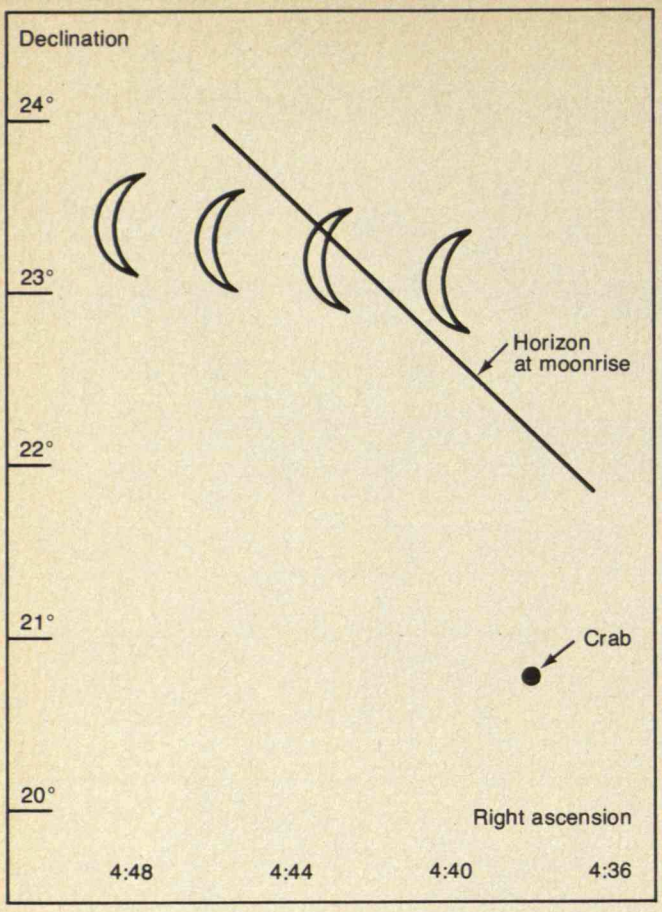
Third, every site we have investigated has a view of the eastern horizon, where the events in question occurred. This is not to say that every pictograph or petroglyph that concerns us lies a few feet away from a vista including the lower eastern sky; some of the sites are deep within caves.





Two examples of rock art thought to represent the supernova of 1054 A.D. — the supernova, or stellar explosion, that created the Crab Nebula. Both of the records shown in the illustration were found in Arizona; both of them are about four to six inches in height; and both of them show a crescent — apparently the moon — in close contiguity to a symbol often used by Indians of the American Southwest to represent a bright object. The record at the top is a pictograph, an image painted or chalked on rock. The image at the bottom is a petroglyph, an image chiselled directly into the stone. It should be emphasized that neither of the records can be dated; it is not even known which tribes produced them. Archaeological excavations have shown, however, that people did live near the sites of the rock art in the middle of the eleventh century, the time of the explosion in the sky. The photographs appear through the courtesy of the photographer, William Miller.

Pictographs at Fern Cave, in Lava Beds National Monument, northern California. The larger photograph shows several square feet of the wall of the cave, and includes a crescent in close contiguity to a circle. These are the symbols thought to depict the supernova of 1054 A.D. The smaller photograph is a close-up of the pictographs in question.



The positions of the moon and the Crab Nebula (or the supernova that produced it), as seen from Fern Cave in northern California on the morning of July 5, 1054 A.D. — close to the day of maximum supernova brightness, according to Chinese records. The coordinate labels for the illustration are those typically used in astronomy; through the application of such coordinates, the stars stand still, and so does the Crab Nebula: it appears at the lower right of the illustration. But both the moon and the horizon move across the unchanging background of the stars. The moon moves from right to left. It is shown at four positions, each an hour later than the preceding one, so that the rightmost crescent shows its position three and three-quarter hours before sunrise, and the leftmost shows it three hours later, and three-quarters of an hour before sunrise. The horizon also moves from right to left, but its sweep across the diagram is far more rapid than that of the moon: it moves five times the horizontal length of the chart in an hour. Accordingly, only a single position of the horizon line is shown: it is frozen at the moment of moonrise in northern California on July 5, 1054. Note the close association of the crescent moon with the supernova at that time.

Still, no site is low in some valley from which the eastern horizon cannot be seen. And even if the site is in a valley it lies on the western side, sometimes on a cliff, so that one can look across the valley and see the sky location shown above.

The cave to which Muriel Kennedy referred in her letter is called Fern Cave. Its entrance is blocked by a wire mesh, for the cave is remote by anyone's definition, and yet some people like to vandalize rock art. One of the pressing reasons for documenting one's discoveries is that sometimes the investigator returns to the site and finds that the art has been mutilated. In some cases, rock art has been used for target practice.

Fern Cave itself is a lava tube that runs for several hundred yards. In one place the roof of the cave has collapsed, producing a small mound of debris on which a colony of ferns about fifteen feet in diameter has grown — thus the cave's name. For almost as far as you can walk, the cave walls are covered with pictographs, including the one mentioned in Mrs. Kennedy's letter. Several of them have been destroyed. Some years ago, for example, a newspaper in the Pacific Northwest decided that the pictographs would be be an interesting subject for a series. Photographers sent to the cave found that the pictographs didn't photograph very well. To bring them out, they outlined some of the symbols with chalk.

The records at Fern Cave were probably made with a bit of charcoal — a burnt stick or a burnt bone, perhaps. The photograph on pages 34-35 shows the wall containing the possible supernova record. A close-up photograph on page 34 shows detail.

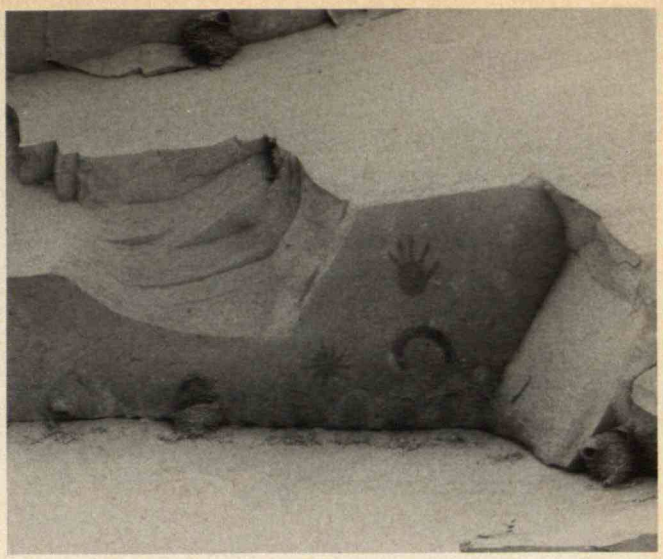
Near Fern Cave is a second group of records, at a site known as Symbol Bridge. Although it is exposed to the elements, crescents are still visible on the rock face there, as shown in the photograph on page 38. One crescent is situated just above the cross in the photograph; another is at the left of the photograph and is not easily visible; a third is at the bottom. The presence of three crescents is remarkable, for crescents are quite rare: there are probably only thirty or forty "respectable" crescents reported in the entire rock-art literature. Anthropologists who have studied the rock art of California and eastern Nevada, for example, have published a table of 58 common form elements. The list includes circles, dots, wavy lines, and so on. Crescents are not included. New Mexico furnished a second example. That area is the research province of Colonel James Bain (Retired). He searched for us through his entire collection of 35mm slides, and found only three crescents, two of which we think are relevant to our investigations.

Given these circumstances: that the crescent is a rare element in rock art, that in some records the crescent is placed in contiguity with a bright object, and that three crescents, or very roughly 10 per cent of all the known crescents in American rock art, appear on a single rock face in the same general area, as a crescent-and-bright-object combination — given all this, we are encouraged to believe that the Symbol Bridge site may be another record of the supernova.

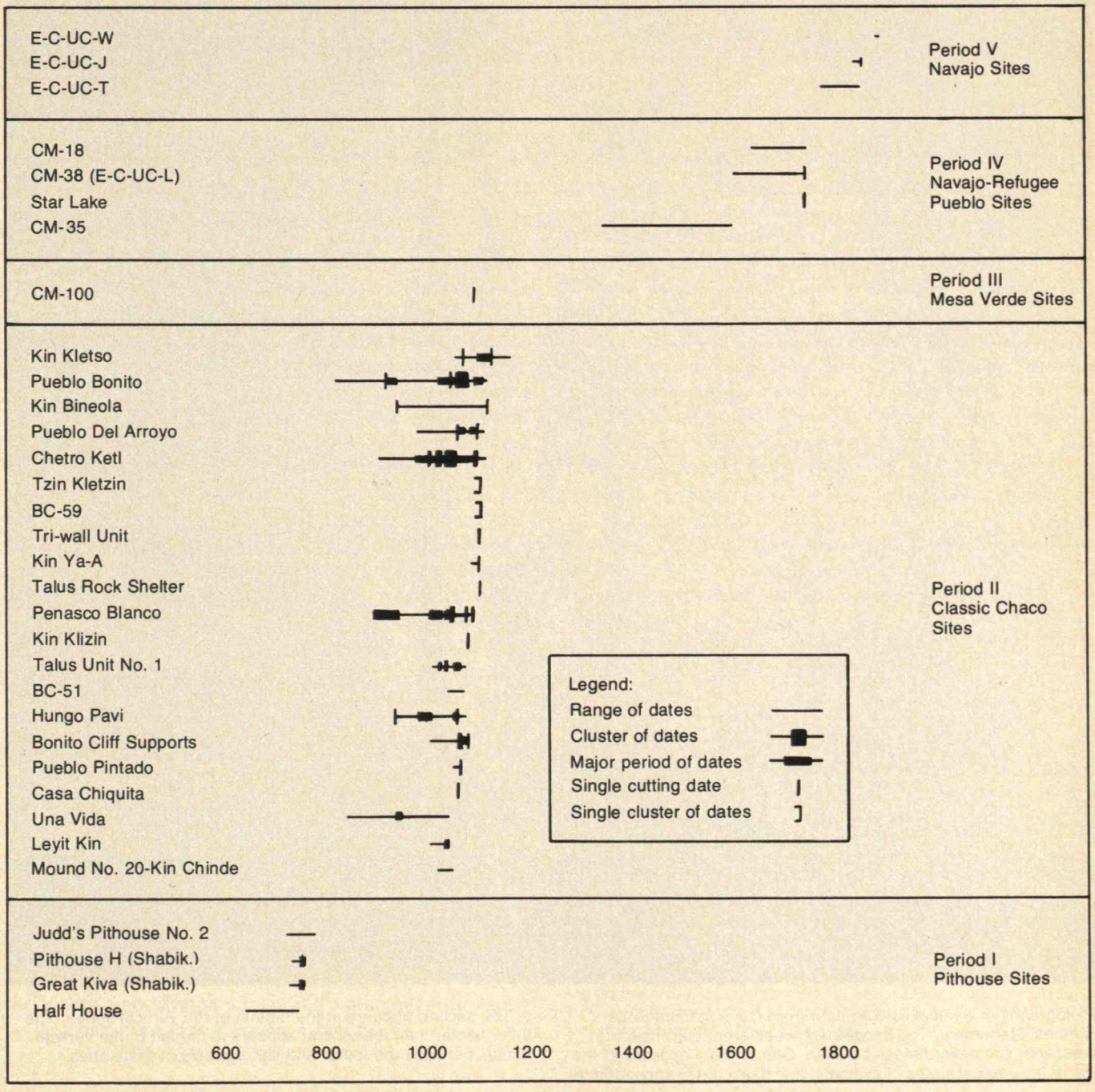
We tend also to regard it as a great stroke of luck that the two symbols composing the records which most interest us are different yet easily recognizable, and that one of them is a crescent, rare though they are. One could easily imagine the record as consisting of just two bright-object symbols close together, and in that case, one could spend the rest of one's life trying to figure out the correct interpretation.

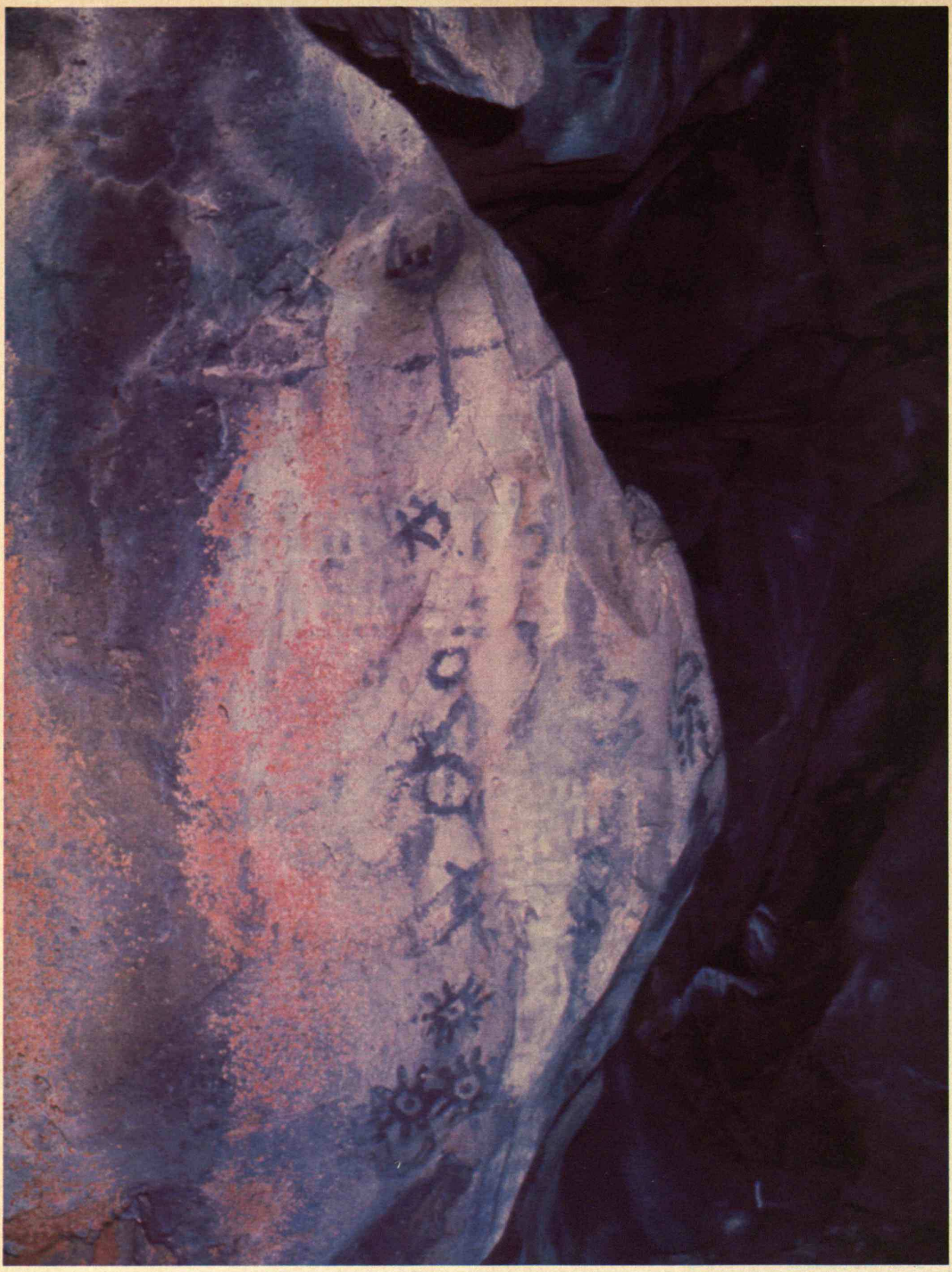
The site we consider to be our best lies in northeastern New Mexico in Chaco Canyon National Park. It lies, in particular, at the base of a cliff whose top is occupied by one of the major pueblo dwellings in Chaco Canyon. The dwellings are collectively called Peñasco Blanco — a

Right: Pictographs at Chaco Canyon, New Mexico. The camera was pointed upward; the three images at the center of the illustration thus appear in truth on the underside of an overhanging rock. The uppermost of the three is the imprint of a left hand; beneath it are a crescent-shaped symbol plainly reminiscent of the moon and an asterisk-like symbol thought to represent the supernova of 1054. A fourth pictograph, this one a sun-watching symbol, marks a place from which the rising of the sun was lined up on certain days of the year with landmarks on the horizon.



Below: A tree-ring dating of archeological sites in the Chaco Canyon region of New Mexico. The crux of the technique is simply that the thickness of rings in the trunk of a tree is roughly proportional to rainfall from year to year. Accordingly, core samples taken from the trees in a given region will show a characteristic pattern, and if the rings in some of these cores can be correlated with a particular sequence of years, then older rings within that core — and similar ring-sequences in other trees — can be dated. Proceeding in that fashion, one establishes a dating system that can be used for core samples taken from trees used in the construction of ancient buildings. Peñasco Blanco, a site where crescent-and-bright-object symbols have been found, turns out to lie in the middle of the "Classic Chaco" period. Notice that a "major period" appears at 1054 A.D.





Pictographs at Symbol Bridge, near Fern Cave in Lava Beds National Monument. The images are weathered, but three crescents can nevertheless be seen. One of them appears at the top of the vertical series of symbols, and has a cross appended to it. The second appears at the bottom of the vertical series. The third, fainter than the others, appears to the left of the vertical series, between the fourth and fifth symbols of that series.

Spanish name that almost surely has no similarity to the name they had when they were populated. Two pictographs at the base of Peñasco Blanco are of special interest. One is a sun symbol, such as is quite often used to mark sun-watching sites: places where people could line up a pillar or some other nearby fiducial mark with a particular point on the horizon. The other represents the supernova — or we hope it does; and this second symbol appears not to mark a location at all. Instead it is situated in one of the most secure places one can imagine: it appears on the underside of a small overhang. The pictographs in question are shown on page 37. The small, gourd-like objects in the photograph are nothing archaeological; they are birds' nests. The crescent and supernova make a good approximation of the sky on the morning of July 5, 1054. Notice that the imprint of a left hand is nearby. Among ourselves, we say that it is the artist's signature.

I mention the Peñasco Blanco site in order to point out a big weakness in the kind of work I am describing: We may have a good idea of what the sky looked like when the supernova appeared, and we may establish a date for the supernova in which we can place confidence. What we cannot do with any degree of confidence is date the pictographs and petroglyphs. The carbon in Fern Cave cannot be dated; there isn't enough of it. The records at Peñasco Blanco, which were probably made with hematite, cannot be dated; no method exists. All we can do is determine the time when the nearby civilization was flowering, and argue by inference that this is the most likely time for the record to have been made. To my mind, this is the weakest link in our archeoastronomical work.

Even so, the available evidence is somewhat encouraging. The chart on page 37 is a tree-ring dating diagram for the Chaco Canyon area. It shows that the years around 1050 A.D. were a time of considerable activity in Peñasco Blanco. This finding is supported by archaeological research in Chaco Canyon; the archaeologists concur that the middle of the eleventh century was its Golden Age. Despite all this, we simply have no way of knowing if 1054 A.D. was the year the putative supernova record was made. Indeed, it is not at all obvious that the supernova should have been recorded as it happened. My own view is that the supernova would most likely have been recorded if it had fortuitously coincided with some other significant event in the life of these people. After all, if you go to Bayeux, France, you can see a tapestry depicting the invasion of England by the Duke of Normandy. Halley's comet also appears on the tapesty, but nobody in his right mind thinks that the people who wove it meant to commemorate that bit of astronomy. It just happened that the comet appeared at a propitious moment and could be interpreted in the context of important political events occurring at the time. My guess is that the likelihood of recording *any* event in the heavens would be enhanced by the occurrence of some remarkable event on earth. Perhaps the supernova of 1054 A.D. occurred simultaneously with a good hunt, a favorable battle, plentiful crops — or a bad hunt, a lost battle, a famine.

Two arguments can be made against our interpretation of the petroglyphs and pictographs I have shown; both are made by anthropologists. One of these arguments is that the records we think commemorate the supernova were in fact only symbols used to mark sun-watching stations. Now we do not dispute the fact that there are sun-watching stations, and that symbols might have been drawn or chiselled to mark them. Still, you'll notice that in Chaco Canyon, for instance, the record that interested us isn't out in the open where anyone could see it. The record is on the underside of a rock face. It is quite hard to find (and I hope it remains hard to find, considering the threat of vandalism). On the other hand, the sun-watching symbol at Chaco Canyon is painted on a vertical rock face and can be seen from anywhere in its immediate vicinity. I should also point out that several of our sites are in caves.

The second objection to our work is an ethnographic one: the argument has been made that the people thought to have lived in western North America at the right time to see the supernova would not have kept records of *anything*. It is certainly true that the Pueblo Indians from whom informants are drawn by anthropologists generally are reluctant to keep records. It is objectionable, however, to extrapolate 900 years from this statement. After all, the American Indian has undergone massive cultural trauma in the last millenium.

The search for supernova records has been fairly productive: we are now aware of over 15 sites spread over western North America, in Arizona, Baja California, California proper, New Mexico, Utah, and Texas. Each such site includes records showing the combination of a crescent and a bright object, and each such record is a reasonable representation of the remarkable events in the sky on the morning of July 5, 1054 A.D. Considering the scarcity of crescents in American Indian rock art, the fact that the close conjunction of moon and supernova was visible only in western North America, and the fact that the archaeological evidence indicates eleventh-century habitation near the sites, we believe we have a strong, if circumstantial, case that the American Indian, when a supernova appeared in the sky, acted much as did the Chinese and Japanese on the other side of the earth: he recorded the event.

For further reading:

"Possible Rock Art Records of the Crab Nebula Supernova in the Western United States," by J.C. Brandt, S.P. Maran, R. Williamson, R.S. Harrington, C. Cochran, M. Kennedy, W.J. Kennedy, and V.D. Chamberlain, in *Archaeoastronomy in Pre-Columbian America,* A.F. Aveni, editor; University of Texas Press, 1975.

"Rock Art Representation of the 1054 A.D. Supernova: A Progress Report," by J.C. Brandt and R. Williamson, in *Essays in Native American Astronomy,* A.F. Aveni, editor; University of Texas Press, 1977.

John C. Brandt is Chief of the Laboratory for Astronomy and Solar Physics at the Goddard Space Flight Center of the National Aeronautics and Space Administration. After receiving his A.B. from Washington University and his Ph.D. from the University of Chicago, he held teaching positions at the University of California, Columbia University, and New York University, and research positions at Kitt Peak National Observatory. He joined N.A.S.A. in 1966.

The First Scientific Instruments

The surviving instruments are often so fragmentary that considerable imagination is required to unravel their construction and use. Still, such efforts must be made if we are to learn about the researches of the ancients.

Sharon Gibbs
National Archives

The early history of astronomy has proven to be a field rife with conjecture and speculation; and while it is difficult to find a single reason that will acount for this, it seems certain that the nature of the evidence itself has had a great deal to do with it. After all, what remains to us of the science practiced by ancient cultures is just revealing enough to require considerable interpretation, yet this evidence, such as it is, represents our only hope of understanding the origin and extent of early interest in astronomical matters. By reviewing in this article a selection of the material with which the historian of ancient science must work, I hope to communicate some sense of its challenging potential. Unlike other writers in this issue who focus on architectural structures that seemingly were used for astronomical activity, I intend to emphasize small-scale remains. I will consider them in roughly chronological order beginning in prehistory, and I will group them into objects from the Old World (more specifically, the area surrounding the Mediterranean) and the New World (the American continent).

A putative shadow clock, and an accompanying hieroglyphic text, from the wall of the cenotaph of Seti I, a pharoah of Egypt. The putative clock is the L-shaped object above the columns of hieroglyphics. Above the clock is a single line of glyphs, which reads: "Knowing the hours of the day and night. An example of fixing noon." In the text below the clock, one finds the words "sun" (the combination of a vertical straight line and a circle), "shadow" (the combination of semicircle, vertical line, and fan or sunshade), and "hour" (the combination of rabbit, pot, semicircle, crown, and star); all three appear, for example, in column 10.

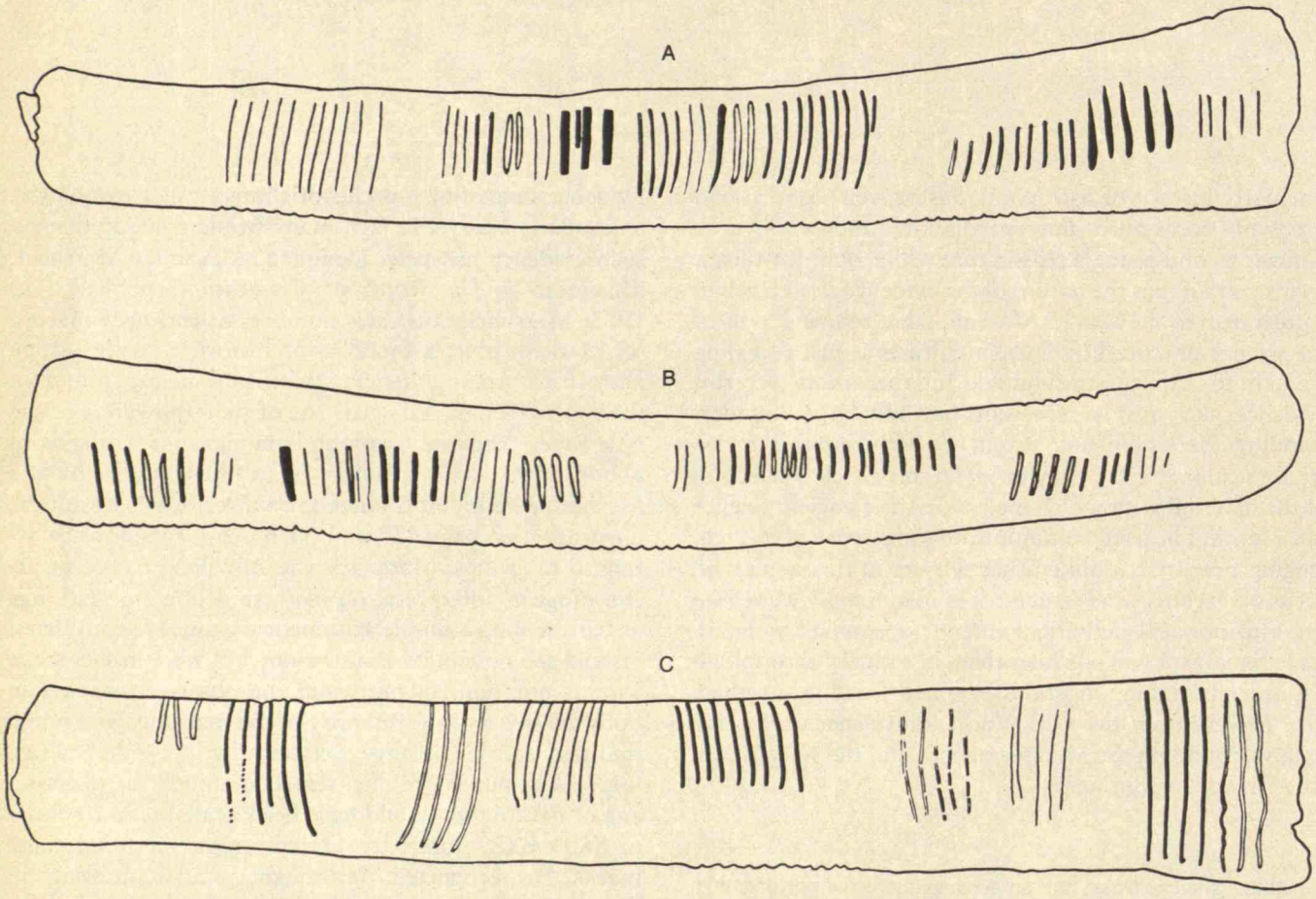
Evidence suggesting a prehistoric interest in astronomy is particularly elusive. In fact, many would contend that no such evidence has been identified. Alexander Marshack disagrees. In *The Roots of Civilization*, published in 1972, Marshack illustrates numbers of curiously marred (or marked) objects found at prehistoric sites in Europe and Africa. Among them is a notched bone tool found on the shores of Lake Edward, one of the headwaters of the Nile River. The tool was found among ruins dating from about 8500 B.C., placing it in the middle of the Mesolithic Period. It is notched on three sides (consult the illustration on page 42), and the notches appear to be arranged in groups. Marshack was unwilling to accept archaeologists' interpretation of these deliberate markings as representing a simple arithmetical game. He considered instead the possibility that the notches were in fact some sort of notation. In particular, he observed changes in both the size and the intensity of the markings and noted that they seemed to have a certain rhythm — or "phrasing," as he put it. He then searched among the phenomena of nature that would have been available to a culture of 8500 B.C., hoping to find the motivation for these marks. He recognized, he thought, similar phrasings in the motion of the moon; that is, he recognized that the intervals of marks on the bone separating the most obvious changes in size and intensity seemed to correspond to intervals of days separating significant lunar events such as new moon, quarter moon, and full moon.

Marshack's identification of the Lake Edward bone as an early scientific instrument well illustrates the role of

the investigator's imagination in the interpretation of evidence unaccompanied by written or even pictographic documentation. Remains from a period some 6,000 years after the marking of the Lake Edward bone, and from an area some 6,000 miles closer to the Nile Delta, represent an interpretive problem of an entirely different sort. In 1300 B.C., the decorators of the cenotaph of Seti I, a Pharoah of Egypt, depicted on the ceiling of the cenotaph an object with an accompanying text discussing "sun," "shadow," and "hour." (See the figure on page 40.) Twentieth century excavators recognized a clear relationship between this cryptic but illustrated text and the fragments of objects found in other tombs in the area. The few lines of written evidence and the few fragments of unwritten evidence combined to point to early Egyptian use of the shadow clock: the sundial. But the details of its use were not so readily revealed. Still, information about the duration of Egyptian hours was to be found between the lines — the lines, that is, on the fragments of the putative dials. Based on this interpolated data, historians of astronomy were able to conclude that while every Egyptian day was divided into 24 hours, the duration of these hours had no precise definition.

Written and unwritten evidence relating to the early history of astronomy continue to complement each other into the Hellenistic period, when both types of evidence become less fragmentary. An example of the relation between the two can again be found in the practice of marking time by means of changing shadow lengths, for the architect Vitruvius, writing in about 25 B.C., briefly discussed dial making and listed types of dials that were familiar to him. The names on this list conjure no clear images of the objects to which they refer. Fortunately, however, a number of monumental and portable shadow clocks have survived from antiquity to add meaning to Vitruvius's work. Monumental stone sundials (designed to be used at a single latitude) have been excavated from about 100 Hellenistic sites around the Mediterranean from Spain to the Middle East.

The oldest datable Graeco-Roman sundial (shown at the right) serves to illustrate the kind of information conveyed by the unwritten evidence. The dial was found at Heraclea ad Latmum, in what is now western Turkey. As is most often the case with ancient dials, its metal, shadow-casting gnomon is missing. The dial has an inscription on its base that comprises not only a dedication

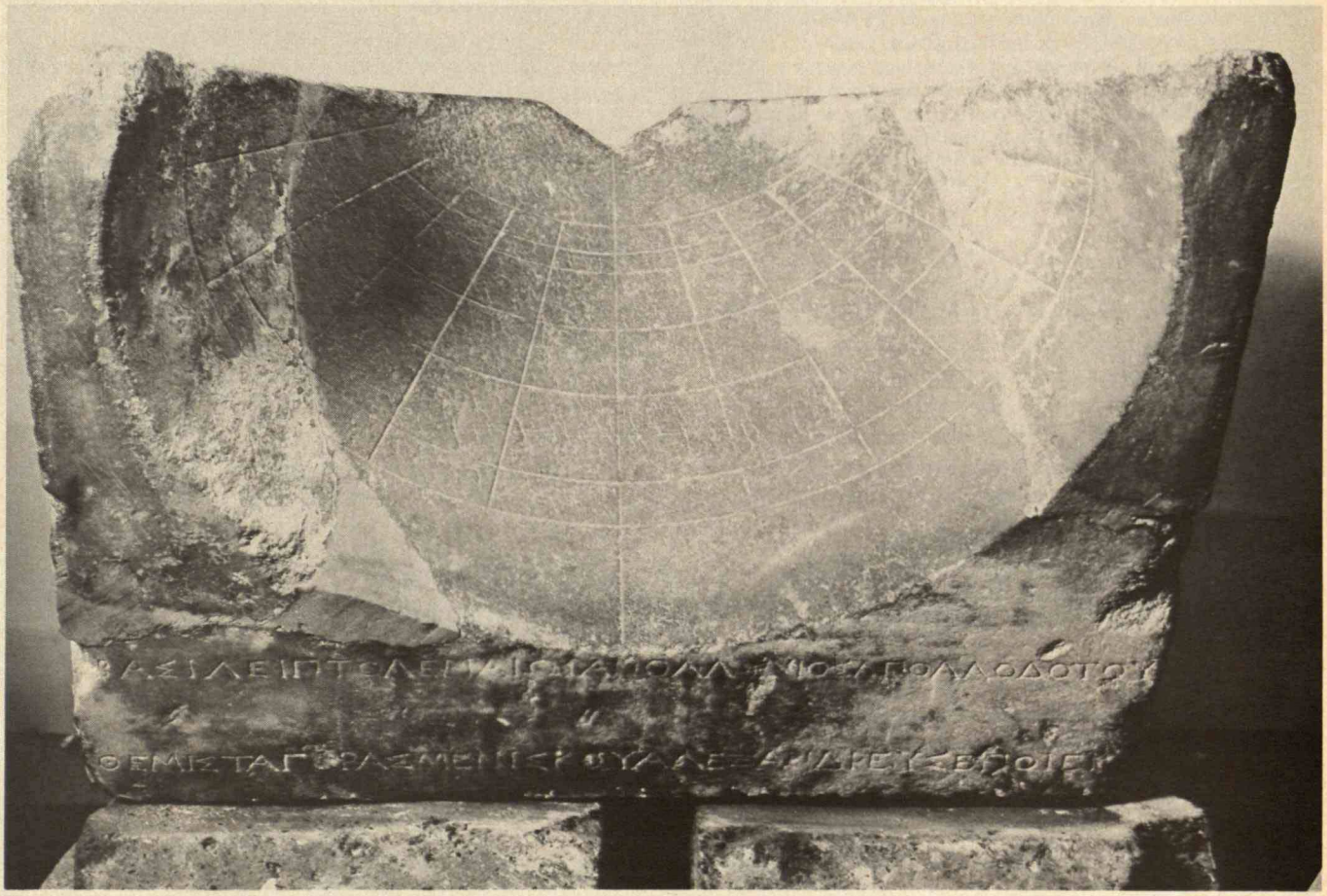


The so-called Ishango bone, an artifact of he Ishango culture, which lived 8,500 years ago at a fishing village on the shore of Lake Edward, Africa. The bone was evidently the handle for an implement of some sort, possibly a writing instrument, for a small piece of quartz, visible at the left in (A) and (C), is still affixed to the shaft. The bone is most notable, however, for three rows of notches incised into its surface; the notches are further subdivided into groups of varying length and thickness. Alexander Marshack has proposed that the rows shown in (A) and (B) each mark out a total of two lunar months, one scratch added each day. To be sure, an exact lunar month is 29.5 days, but if one looks to the sky and counts the number of days between successive times when the moon is new (that is, invisible), one may count anywhere from 28 to 31 days. Marshack explains the possible significance of the various scratch subgroupings in his book, *The Roots of Civilization,* from which this illustration is adapted.

but also an identification of its maker, a third century B.C. craftsman. All of this is unusual: most extant Greek or Roman sundials have no inscription of any sort. Now the precise workmanship evident in the sundial reveals an important Greek refinement of the essential Egyptian technique, for all functional Greek dials show not only the hour of the day but also the day of the year. Both measurements would have been indicated by means of the shadow cast by the gnomon. Thus the Greek sundial is a shadow calendar as well as a shadow clock; its design gives the impression that the Greeks had embodied within it a model of solar motion. In the dial shown on page 44, concentric lines curving across the sundial's face mark the path of the sun during the day of the winter solstice (upper curve), the spring or fall equinox (middle curve), and the summer solstice (lower curve). The central, vertical line immediately beneath the gnomon marks the meridian, i.e., noon. The point of the gnomon's shadow in the figure marks the end of the fourth hour on the day of summer solstice.

The relation between the sun's position on the celestial sphere and the lines on a hemispherical dial face is diagrammed in the figure on page 45. Several lines in the diagram connect the points that mark the position of the sun at the end of a certain hour on three days of the year. Such hour-points divide each of the sun's daily paths between sunrise and sunset into 12 equal parts. It is these curves, points, and connecting lines which are projected through a gnomon point onto a smooth surface to create a functioning Greek sundial. The complexity of the resulting projection is dictated by the shape and orientation of the dial face.

Both written and unwritten evidence combine to establish the fact that in the Hellenistic Age the notion of an hour had become precisely associated with the changing position of the sun. Though the duration of this "hour" varied during the year, being shorter in winter and longer in summer, at least it did so predictably. Both written and unwritten evidence also combine to document the extent of Graeco-Roman knowledge and utilization of projective geometry, for the almost 300 surviving Graeco-Roman dials confirm that the design of an accurate shadow clock and calendar required a fairly sophisticated geometrical sense. It surely comes as no surprise that Vitruvius identifies a number of astronomers and mathematicians as designers of sundials. In Book IX of *De Architectura*, he



The earliest known Hellenistic sundial, from the collection of Greek and Roman Antiquities in the Louvre Museum, Paris. The dial, about one foot in height, is substantially intact, except for its gnomon, the projection point whose sweeping shadow marked the passage of time. The front face of the dial has the shape of a portion of a cone. Seven concentric half-circles are inscribed into its surface. They mark the path of the sun across the sky (that is to say, they mark the path of the shadow of the missing gnomon) on the days when the sun entered each sign of the zodiac in the course of its yearly passage through the sky. The shadow passed along the curve for summer solstice (lowest curve) and the curve for winter solstice (uppermost curve) once each year; it passed along each of the other curves twice. Intersecting all of these curves is a set of lines that divides each day into "hours." (Photograph by Chuzeville, Musée du Louvre)

attributes the so-called quiver design to Apollonius, the mathematician who developed the theory of conic sections. ("Quiver" refers to the appearance of the device: lines flow from its center like arrows spilling from a quiver.) He attributes the planar-disc design to Aristarchus of Samos, who is best known for proposing, long before Copernicus, that the sun was the center of the solar system. Aristarchus's disc was designed to function in the plane of the meridian, with gnomons perpendicular to surfaces facing east and west. Finally, he attributes the day-curve, hour-line network, independent of the specific shape of the dial on which they are projected, to Eudoxus of Knidos, an astronomer of the fourth century B.C. whose cosmological views were adopted by Aristotle.

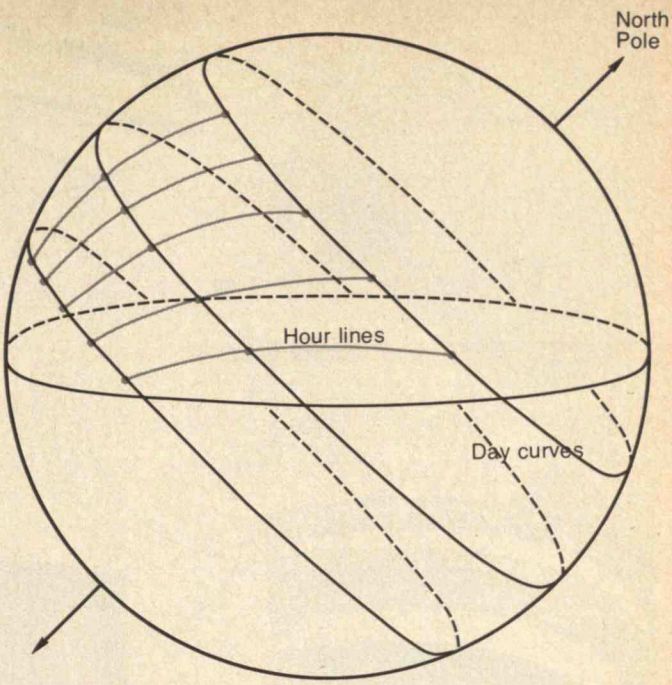
Vitruvius's list of dials and inventors, together with the quality of the remaining dials, really only hints at the relations that may have existed between the science of gnomonics (or dial making) and other scientific activities in antiquity. The nature of these relations must therefore be inferred. An example of an attempt to do so exists in Otto Neugebauer's proposition (suggested several years ago) that the development of the planar sundial moti-

The end of the fourth hour on the day of summer solstice is marked by the shadow on a sundial in the Museum of History and Technology in Washington, D.C. The dial is a model of an instrument found in Athens, and preserved in the Rijks Museum in Leiden, the Netherlands. The lowest of its day-curves is crossed not only by hour-lines, but also by shorter line-segments that evidently delineated half-hours.

vated the discovery of the conic sections. His proposed connection has proven difficult to document, partly because very few planar sundials survive. A much stronger case can be made for the contribution of dial making to the sciences of astronomy and geodesy, for the most reliable account we have of the efforts made by Eratosthenes to measure the circumference of the earth reports that his instrument consisted of two hemispherical sundials, one in Syene, the other in Alexandria. On a day when the sun over Syene cast no shadow at noon, the sun over Alexandria cast a shadow that indicated a seven degree difference in inclination. From that observation, and knowing the distance from Syene to Alexandria, Eratosthenes calculated the earth's circumference. We also know from ancient sources that the astronomer Meton set up a sundial on the Pnyx in Athens to aid his fifth-century B.C. researches. Although it has not survived, scholars have suggested that it was similar in design to a well-preserved, very large dial set up just below the Acropolis wall.

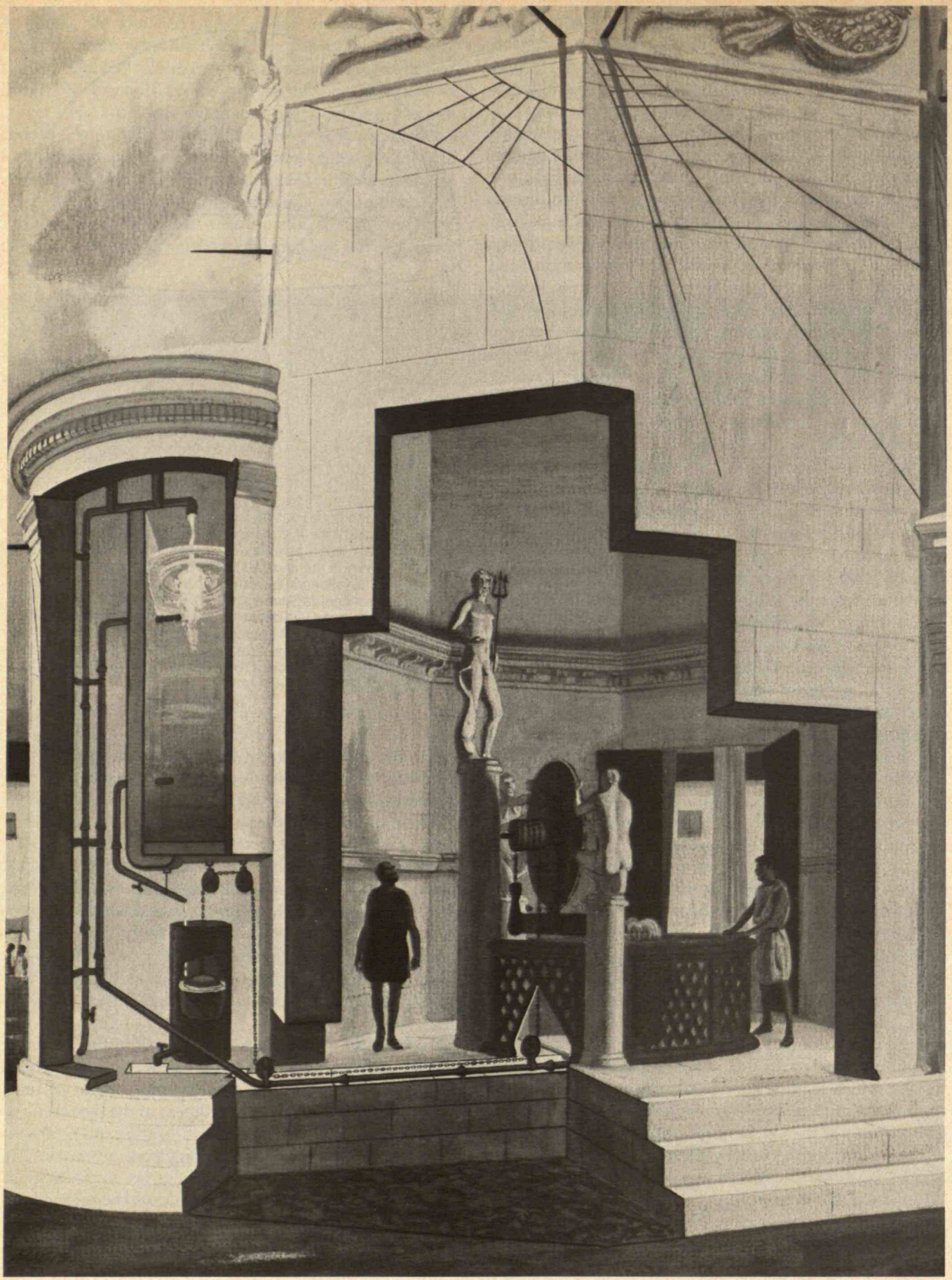
The corpus of Greek and Roman sundials contains one example which also seems to document the development of mechanical technology in the last decades of the pre-Christian era. The extent to which it does so depends heavily, however, on an interpretation of some puzzling, unwritten remains within a context of written remains. The puzzling, unwritten clues can be found inside the Tower of the Winds in Athens. The tower itself, mainly octagonal in shape, is mentioned by Vitruvius, who attributes its design to Andronicus, a Macedonian astronomer. Its outer surface is decorated with fine planar sundials and also with relief sculptures depicting the personified figures of the winds. As for the inside of the tower, nothing remains, except for some curious holes and grooves in the stone floor and walls, to verify its ancient use. Still, the placement of the holes and grooves in the octagonal part of the structure, and also in a semicylindrical annex to the main octagon, convinced Derek Price and Joseph Noble that the tower once housed an elaborate water clock of a type known to Ktesibios, Philon, Heron, and Vitruvius. Price and Noble propose that the upper and lower levels of the semicylindrical annex housed a tank which provided a constant head of water, and beneath it a cylinder containing a float. Water in the upper tank fed in a slow drip into the lower cylinder, causing the position of the float to vary at a constant rate. A chain attached to the float ran by a series of pulleys to a weight, which in turn governed the motion of the clock mechanism proper. The figure on page 46 shows their reconstruction of the clock, no part of which survives.

The visual device used by Andronicus to display the ancient, seasonally variable hours in the Tower of the Winds is completely open to conjecture. Price and Noble tend to view it as consisting of an anaphoric clock face like the face described by Vitruvius and preserved, in principle at least, in examples of the planispheric astrolabe. (See the figure on page 49.) An anaphoric clock face consists of a solid, flat disk containing a stereographically projected star map. A fragment of just such a large, flat disk engraved with a star map was found in Salzburg in 1902. It lent convincing evidence to the reconstruction, which includes the ecliptic or zodiac circle — the path taken by the sun through the background of stars in the course of a year — fitted with a moveable marker representing the sun, all of this viewed through a network of stereographically projected hour-lines and day-curves, just like those invented by Eudoxus for projection onto the face of a sundial. When the clock was operating, the flowing water, the pulleys, and the weights combined to cause the star map, with its sun symbol, to rotate once every 24 hours behind the fixed hour-line network.



Day-curves and hour-lines on the celestial sphere. The former are the loci that mark the sun's passage through the sky on any one day of the year, such as a day of solstice or equinox. Three such lines are shown in the illustration; they circle the celestial sphere like hoops. The latter are the loci that connect the same hour of the day across several day-curves; five are shown in the illustration. The exact form of the line network projected onto the surface of any given sundial depends, of course, on the shape of the dial. But the general network as shown here, independent of any single projection system, is credited to Eudoxus of Knidos, a fourth-century B.C. astronomer.

To be sure, the restorers of the clock in the Tower of the Winds, in comparing its visual device to a planispheric astrolabe, have bridged a considerable amount of time, since the earliest surviving instrument of the type pictured on page 49 dates from the tenth century A.D., almost 1,000 years after Andronicus completed his work. The foundation for this 1,000-year bridge lies in the writings of Claudius Ptolemy, an astronomer of the second century A.D. who made crucial contributions to the advance of astronomy, yet himself acknowledged a considerable debt to his predecessors. In an essay on astrological principles, Ptolemy refers to an object he calls an "horoscopic instrument," and says that it contains a "spider" which marks the fixed stars. In another essay, the "Planis-



The waterclock in the Tower of the Winds, Athens, as reconstructed by Derek J. de Solla Price and Joseph Noble. According to the two, the semicylindrical structure at the left contained a water tank and a series of floats, pulleys, and weights, which generated a force to drive a clock in the octagonal structure at the right. (Illustration © National Geographic Society)

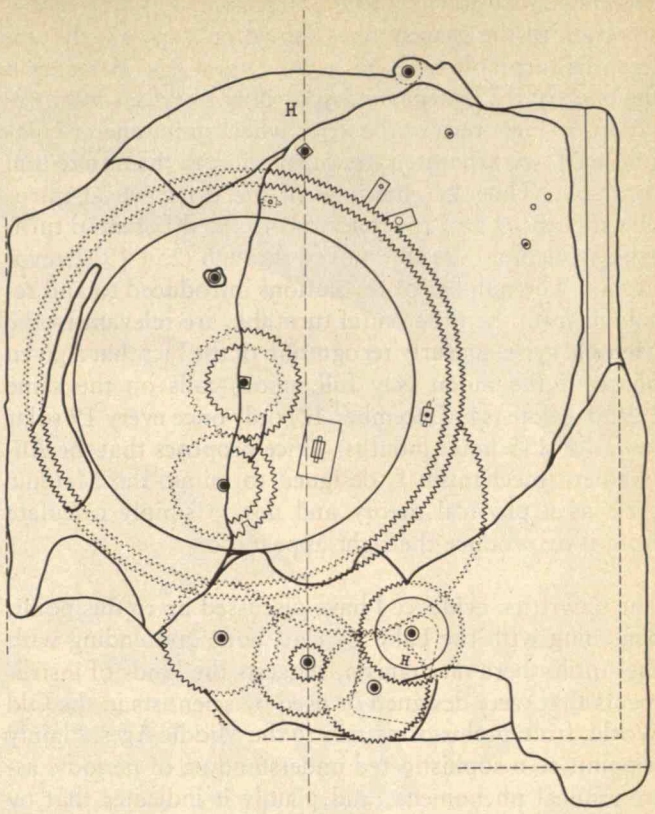
pherium," he describes the method and utility of stereographic projection. These two pieces of evidence have suggested to scholars that Ptolemy was familiar with the astrolabe, in the sense of a skeleton star map which could be rotated above a solid plate engraved with day-curves and hour-lines for a specific geographic latitude. Obviously a certain amount of inference is necessary if one is to place a two-part "horoscopic instrument" in Ptolemy's hands. The evidence only indicates that he could have constructed and used an astrolabe as we know it.

The thousand-year gap between Ptolemy's reference to an horoscopic instrument and the earliest surviving astrolabe has been explained, incidentally, by the same factor which explains the rarity of metallic instruments in general: i.e., lack of materials. At times when new metal was generally unavailable, the old pieces (including most of the bronze gnomons of monumental sundials, all but a handful of the small portable dials, and apparently all of the "horoscopic instruments") were pressed into service.

Whatever the scarcity of the evidence, the task of interpreting it in historical times is made easier when the written and unwritten evidence complement one another, as has been the case in the examples discussed so far. One cannot always expect to find complementary evidence, however; and indeed, isolated bits of unwritten evidence as puzzling as those from prehistoric times also turn up in later periods. One such bit of evidence went without a complete interpretation for almost 75 years before its relatively sophisticated mechanical characteristics were recognized. In a way, this is easily understandable, for the device seems quite extraordinary when it is placed among sundials, water clocks, and horoscopic instruments.

In the spring of the year 1900, a group of sponge divers was forced off its normal course by bad weather. They ultimately dropped anchor off the island of Antikythera, situated in the Mediterranean between Crete and the mainland of Greece. The divers had never examined this area for its sponge fishing possibilities, so they made the best of their situation and did so. In the course of this exploration, they found the ancient wreck of a large ship. Within it were several bronze and marble objects, which they brought to the surface. And among those objects were four bronze fragments, apparently related to one another, but all heavily corroded. They were eventually dated at 87 B.C. During the years that have followed their discovery, scholars have determined that these fragments were part of a geared mechanism built on a series of bronze plates. Gamma-ray photographs taken in 1971 confirmed this determination.

The photos also led to an interpretation of the significance of the gearing. In 1974, Derek Price reported that "The [Antikythera] mechanism can now be identified as a calendrical Sun and Moon computing mechanism, perhaps made by a mechanician associated with the school of Posidonios on the Island of Rhodes . . . The most spectacular aspect of the mechanism [Price continued] is that it incorporates the very sophisticated device of a differential gear assembly . . . [Before this interpretation, the differential gear was thought to have



The gear assembly of the Antikythera mechanism, as reconstructed by Derek J. de Solla Price. The gears themselves, as discovered by sponge divers in 1900, were simply a set of heavily corroded metal objects. But Price, basing his conclusions in part on the numbers of teeth in the various wheels, determined that certain aspects of their revolutions correspond to certain aspects of the Metonic cycle, an attempt to reconcile the passage of solar and lunar time. The number 235, for example, is embodied by the gears, and the Metonic cycle is 235 lunar months long; that is to say, 235 lunar months is a lowest common denominator in the periodicities of the sun and the moon.

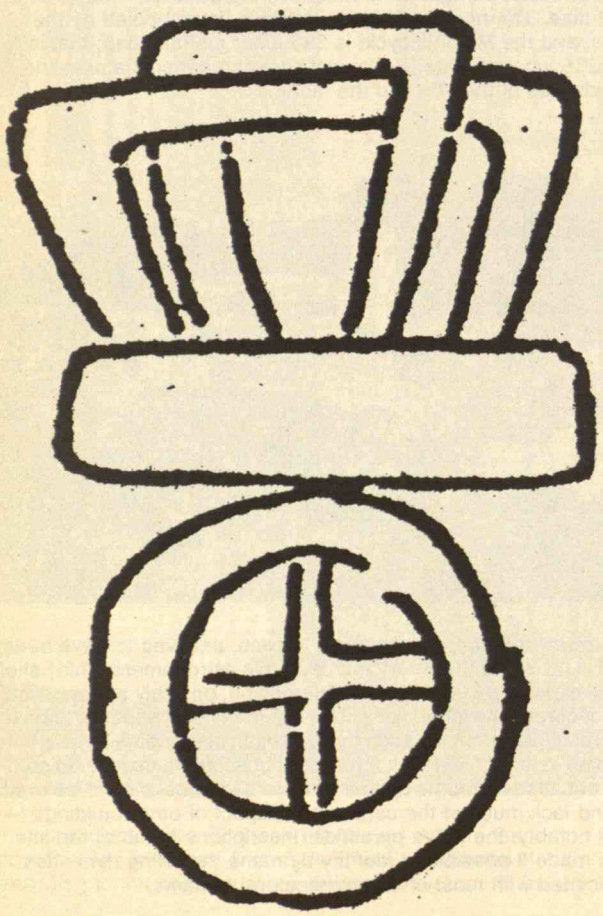
The tower at Palenque, Chiapas, Mexico, believed to have been used in the seventh century A.D. by Maya astronomers. This belief, however, is based entirely on a hieroglyph, possibly astronomical, that decorates its inner walls. The site in general appears to have been occupied from the sixth through ninth centuries; we have little to go on in identifying it as a palace, but scholars usually do so, if only because its rooms appear to have been designed to be lived in, and lack much of the ceremonial aspect of other buildings — most notably, the Maya pyramids. Inscriptions found at the site have made it possible to identify by name the ruling dynasties associated with most of the architectural remains.

originated just previous to the Renaissance.]" In a reconstruction of the gear system, shown on page 47, the differential turntable is visible as the largest gear element on the back of the instrument. According to Price's interpretation, a single turn of the drive wheel simultaneously introduced two separate rates of rotation to the differential turntable. Thus 19 rotations of the drive wheel introduced both 19 and 254 rotations to the differential turntable, which, as a result, moved through (254-19)/2 revolutions. The number of revolutions introduced to and resulting from the differential turntable are relevant to the Metonic cycle, an early recognition of the fact that a given phase of the moon (say full moon) falls on the same calendar date (say December 12) only once every 19 solar years (or 235 lunar months). Price proposes that the Antikythera mechanism is designed to mimic the Metonic cycle as a physical theory and not to simply calculate from it or produce the right appearance.

The unwritten evidence I have discussed up to this point, beginning with the Lake Edward bone and ending with the Antikythera mechanism, suggests the kinds of instruments that were designed or used by scientists in the Old World, from prehistoric times to the Middle Ages. Plainly it points to a sophisticated understanding of periodic astronomical phenomena, and plainly it indicates that by the beginning of our present era, residents of the Old World were adept at applying the mathematics of gnomonic projection, stereographic projection, and gear ratios. We have every reason to suspect that the instruments which survive played a role in the development of Old World science. Certainly the careful interpretation of these instruments can reveal much about the scientific knowledge of their makers.

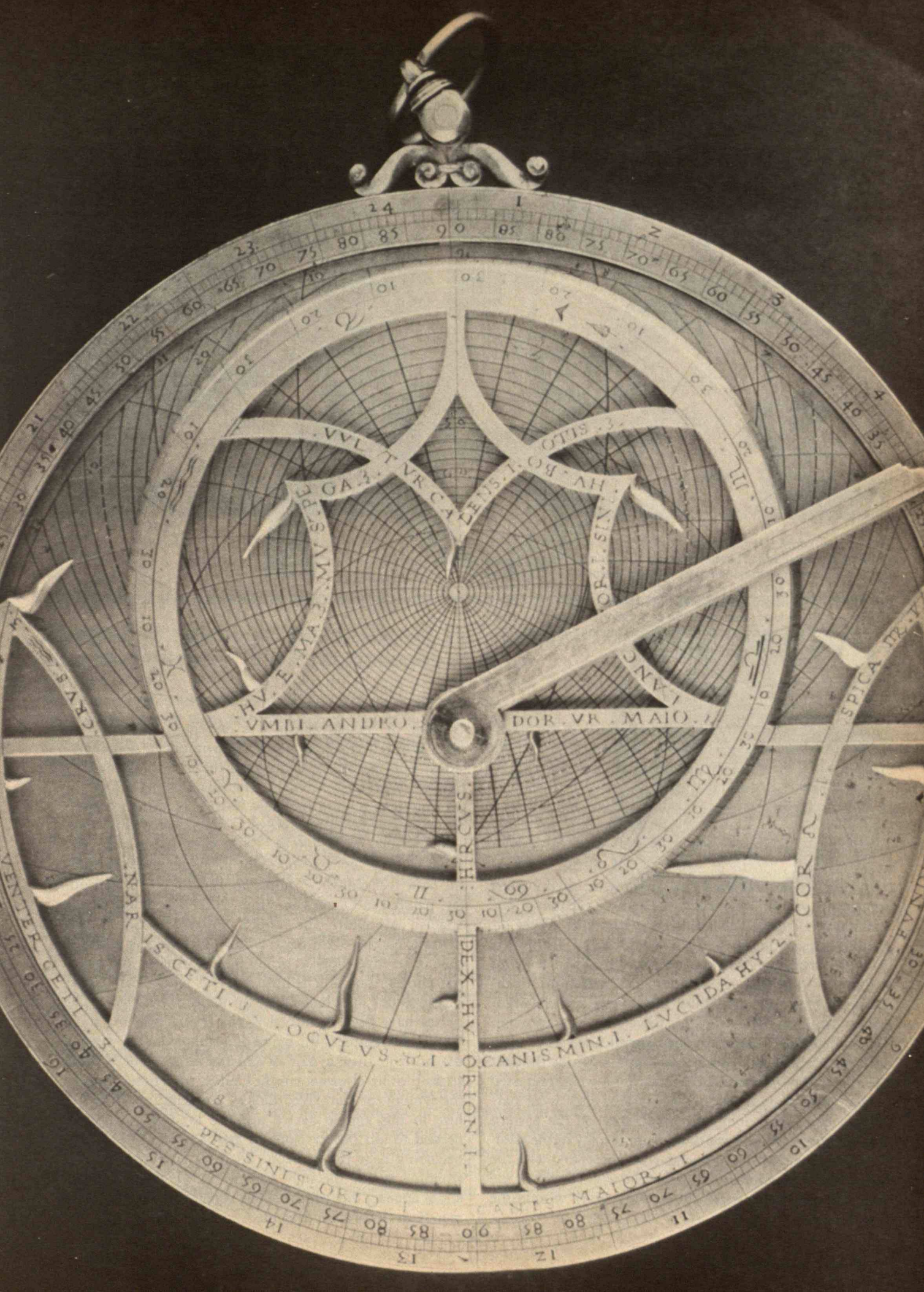
The wealth of information supplied to us from Old World sources seems all the more valuable when it is compared to what little is known about the history of astronomy in the New World. Consider the Tower of Winds in Athens. Even if we have essentially no direct evidence to suggest that it once contained a scientific instrument, we have at least the sundials on the outside of the structure. Accordingly, no flight of imagination is required to suppose that the tower served an astronomical purpose. Compare this with the kinds of clues offered by seemingly analogous structures known from Mesoamerica. A figure on page 47 shows a tower in Palenque, Chiapas, Mexico, that modern-day Palenqueños are convinced was used by astronomers in the eighth century A.D. What clues does it contain to suggest its former use? A hieroglyph associated with the planet Venus decorates its inner walls, but aside from that there is nothing. While the Venus glyph standing alone on the wall of the Palenque tower clearly indicates a Maya fascination with the planet Venus, it cannot convey involvement in astronomical activity as convincingly as does, say, a functioning sundial. The designer of a functioning sundial had to be engaged in astronomical activity. Archeoastronomers can only speculate on possible Maya astronomical activity suggested by the tower's placement and orientation.

A second Mesoamerican example, a round tower at Chichen Itza, Yucatan, Mexico, was identified as an astronomical observatory in 1875, but speculations on the appropriateness of this designation were not carefully analyzed until a century later. What clues now remain? Nothing more than three asymmetrically oriented windows at the top of the tower, and a set of asymmetries in



Left:
An image claimed to be a Mesoamerican shadow-clock, from Xochicalco in central Mexico. The image in question is engraved on the west face of the Temple of the Plumed Serpent, south of its central stairway. The top part of the image has been described as "one trapeze crossing another." It has been claimed, moreover, that one of the trapezes was oriented north to south, the other east to west. If so, the shadow of the north-south trapeze would move from west to east in the course of each day. The site of Xochicalco flourished in the period between 800 A.D. and 1520 A.D. under the influence of Toltec, Zapotec, Mixtec, and Maya peoples.

Right:
An astrolabe made in western Europe in 1542, and now in the collection of the National Museum of History and Technology, Washington, D.C. Price and Noble believe that the clock face in the Tower of the Winds had a similar nature. An astrolabe in general comprises two metal plates, one atop the other. The outer of these is a star-map in the form of a skeleton network; the dagger-like points extending from the skeleton-like scaffolding in the illustration show the positions of prominent stars such as Aldebaran, Regulus, Arcturus, Spica, and Vega. Beneath the network is a solid plate with hour-lines and day-curves inscribed in its surface. Other lines engraved on the upper half of the solid plate are the stereographically projected elements of an earth-centered coordinate system including altitude circles parallel to the horizon and azimuth circles which pass through the zenith.


VMBI. ANDRO.
DOR. VR. MAIO.
HIRCVS.
DEX. HV.
ORION. I.
OCVLVS. ☿. I.
O. CANIS MIN. I.
LVCIDA HY. 2.
COR
SPICA
NAR. IS. CETI. I.
PES SINIS. ORIO. I.
CANIS MAIOR. I.

The earliest known photographs of the windows at the top of the Caracol, Chichen Itza, Yucatan, Mexico. The images, taken by Carnegie Institution archaeologists in 1920 (before they began a restoration of the site), show a set of windows at a curious mutual orientation, suggesting no purely aesthetic and no geometrical significance. However, several of the orientations of windows and other parts of the structure seem linked to positions at which the planet Venus sets on the horizon.

the overall plan of the buildings — primarily in the orientation of the bases on which the tower was built. The figure above shows the earliest known photographs of the windows at the top of the tower. They aren't perpendicular to one another, or at 45-degree offsets. Indeed, they exhibit no obvious mutual relationship at all. The bases, too, face various directions without an obvious geometrical significance. However, the study of all the asymmetries has revealed that several of them are directed toward important setting positions of Venus, including the maximum northerly and southerly such points. These directions appear not only in the windows but also in the base. In particular, the direction associated with a lower stairway in the structure points to the maximum northerly setting position of Venus. Now there are no hieroglyphs depicting Venus on this tower, but the apparent Venus alignments take on added significance when they are considered in the context of Maya religious thought and cosmology. We know that the Maya were interested in the planet Venus; and we know that they were particulary concerned about its appearance on the eastern horizon after it had disappeared from the sky in the west. We also know that round towers were associated with the Venus god in his capacity as god of the wind. Such are the clues that historians of astronomy must work with in the New World.

Graphic or textual evidence is extremely important in New World archeoastronomy, for without it, no conclusions could be drawn concerning the use of instruments by New World astronomers. The reason is that no physical objects remain in the New World, awaiting interpretation in astronomical contexts — no physical objects except the ruins of buildings. To be sure, the graphic evidence is relatively rare and easily misunderstood; perhaps the most well-known example appears in the Codex Bodley, painted in Oaxaca in about 1520, on the eve of the Spanish conquest. The Codex apparently depicts the dynastic history of the royal family in the district from the time of its mythological origin in 692. Among the pictorial conventions is a temple studded with small circles that look like light bulbs. (See the figure above right.) The circles have been identified as the convention for stars. Within the temple is the figure of a Mixtec Indian viewing the horizon over a pair of crossed sticks. The crossed sticks turn up elsewhere in the Codex, sometimes framing the symbol for star. Accordingly, it is tempting to recognize in this simple device just the kind of instrument needed to aid observations of astronomical phenomena occurring near the horizon. But it is also true that astronomy is not the only context in which the crossed sticks appear. Indeed, the sticks sometimes seem to serve merely as decorative devices.

MIT '78

Articles

Departments

Integrating Sciences, Technologies, Humanities and Management: the First Colleges at M.I.T.

Question: what is larger in concept than a department or even a school, has its own faculty as well as embracing teachers in other departments and schools, and is concerned with issues that transcend those of any such unit but are present in many of them; devoted to both teaching *and* research, in contrast to interdisciplinary laboratories and centers whose formal focus is in research?

Answer: a college — a new designation now in use for the first time at M.I.T., taken "from the sense of the word 'collegium' — a group of colleagues," explain President Jerome B. Wiesner and Chancellor Paul E. Gray, '54, in their annual report to members of the Corporation.

One college exists — the Whitaker College of Health Science, Technology, and Management, named in honor of its principal benefactors, Helen F. Whitaker and her late husband Uncas A. Whitaker, '23. Another is in prospect — a College of Science, Technology, and Society, to focus on "the humanistic aspects of technological society: its culture, the lives of its people, their attitudes, perceptions, problems, goals, and prospects," in the words of Drs. Wiesner and Gray in their annual report.

The Whitaker College of Health

The Whitaker College is a reality, assured by gifts to the Leadership Campaign of more than $11 million from foundations and organizations with which the Whitakers have been associated and $9 million from the Pew Memorial Trust of Philadelphia. A $29 million complex is now being designed for a site on Carleton Street, stretching between Main and Amherst Streets; it will contain the Institute's Medical Department, including health care facilities for stu-

From Chairman Howard W. Johnson (left) and President Jerome B. Wiesner to Helen F. Whitaker: resolutions of the M.I.T. Corporation naming M.I.T.'s new College of Health Sciences, Technology, and Management for Mrs. Whitaker and her late husband, Uncas A. Whitaker, '23. "One of the many rewards of being President of M.I.T.," said Dr. Wiesner, "is the opportunity to work with great Americans and great alumni . . . among our severest critics." The College which the Whitakers' enthusiasm helped make possible is "a practical necessity if the Institute is to continue contributions in medical care and its management," Dr. Wiesner said at the annual Corporation Luncheon. (Photo: Calvin Campbell)

Campaign Report: $142 Million at the Half-Way Mark

In the first half of its five-year scheduled lifetime, the M.I.T. Leadership Campaign has reached $142 million, 63 per cent of its $225 million goal — a thoroughly satisfactory performance, says Howard W. Johnson, Chairman of the M.I.T. Corporation, and one which has had a substantial role in the Treasurer's successful effort to match M.I.T.'s income with its expenses *(see page A6)*.

Ahead lies the harder half of the Campaign, because — as President Jerome B. Wiesner and Chancellor Paul E. Gray, '54, admit in their 1977 annual report, "the first half accomplishment was made possible by strong support from individuals and corporations closest to M.I.T." Now the problem is to find sources of support among less familiar and new friends. Of the $142 million now in hand, $51 million came from foundations, $43 million from corporations, and $44 million from individuals.

As the last half of the Campaign begins, some new needs within the original Campaign goals have special emphasis:

☐ A development fund of $10 million for the School of Engineering. Enrollment in the School has been rising sharply; in 1974-75 only 45 per cent of M.I.T. "designated" sophomores were headed for engineering degrees; last year the figure was up to 63 per cent, and such increases in enrollment "have produced stresses which must be relieved," according to President Wiesner and Chancellor Gray. Much of the $10 million would be used to add new, young faculty.

☐ New undergraduate housing. The Undergraduate Houses are overcrowded, figuratively splitting at the seams; more and more undergraduates want on-campus housing, and there's land reserved for a new House near Tang Hall on the West Campus.

☐ New academic buildings — an athletic and special events center, for which $5 million is needed, and a visual arts center ($6.5 million) to house work in film and video, music, and drama.

☐ Completion of the Campaign's $100 million goal for new endowment. So far the campaign has produced $32 million for endowment, representing an increase of $1.6 million a year in income for M.I.T.

In the five years of the Leadership Campaign the Alumni Fund is targeted to provide $26 million — an average of just over $5 million a year. Last year's Fund total of $4.8 was right on target, but complacency isn't in order. "I cannot overemphasize the importance of the Alumni Fund to the continued success of the Leadership Campaign and to M.I.T.," Mr. Johnson told alumni officers at their annual conference in October.

dents and staff, as well as laboratories and classrooms for new research and teaching in human biology, physiology, experimental medicine, and health care management and policy — "a major commitment by M.I.T. to marshal its strengths and resources in science, engineering, and management to bring about progress in medicine and improve the quality of health care in the U.S. and throughout the world," says President Wiesner.

Speaking at a luncheon for the M.I.T. Corporation on October 7, Dr. George W. Thorn, Physician-in-Chief, Emeritus, at Peter Bent Brigham Hospital who is a Life Member of the Corporation, recited a long history of pioneering work at M.I.T. for and with the medical community of Boston — diagnostic and therapeutic x-ray equipment, radioisotope manufacture, prosthetic devices, radiation therapy, food and nutrition research, basic studies of molecular biology, the first synthesis of penicillin, the application of information theory to biological problems, and outstanding research on neurophysiology and brain anatomy.

In Dr. Thorn's view, the new college is "a natural culmination of the Institute's long concern for health care and medical science . . . an outstanding opportunity . . . a practical necessity of the Institute is to continue contributions in medical care and its management." Four medical problems are on Dr. Thorn's agenda for the future: better understanding and treatment of cancer, arthritis, psychological disorders, and cardiovascular disease; and two social/management problems: maintenance of readily available health care facilities at "reasonable cost and satisfactory cost/benefit ratios" for those who are able to pay; and improvement of today's services — which are "definitely substandard" — for those who are economically deprived.

Uncas A. Whitaker, who graduated from M.I.T. in mechanical engineering, was founder, President, and later Chairman of the Board of AMP, Inc., of Harrisburg, Penn. He was a member of the Corporation from 1961 until his death in 1975, and Mrs. Whitaker — who had been a "full partner" with Mr. Whitaker in his support of health-related research and teaching at M.I.T. — has been a member since 1976. Together they made possible a new building — now named in their honor — for the life sciences in 1965. Nine years later they established the Whitaker Professorship in Biomedical Engineering, and they also were responsible for creating a Health Sciences Fund to support research throughout the Greater Boston area.

A College of Science, Technology, and Society

Ever since Dr. Wiesner became President of M.I.T. in 1971, a major goal has been to close the gap between technology and the humanities at M.I.T. His view is that "technological and societal problems are so inextricably interwoven that their relationship should be an explicit subject for research and teaching."

This concern led to development of a wholly new group of scholars within the School of Humanities and Social Science in the fall of 1976 under the leadership of Elting E. Morison, Elizabeth and James Killian Class of 1926 Professor. They include Professor Gerald Holton, on leave from his post as Professor of the History of Science at Harvard; Professor Kenneth Keniston, formerly Professor of Psychiatry at Yale; Professor Leo Marx, formerly a major figure in American studies at Amherst; Professor Carl Kaysen, who is on leave this year to direct a study of university-government relations funded by the Alfred P. Sloan Foundation; and Dr. Robert S. Morison, a distinguished medical scientist and specialist in health care policy at Cornell University. They fulfill a concept which President Wiesner and Chancellor Gray described to the Corporation in October: "a new entity within M.I.T., having a faculty and a fellowship of scholars from many disciplines and departments, an undergraduate teaching program, a research center, and an organization to support continuing study groups addressing themselves to selected contemporary problems.

"The intellectual purposes of the College are clear: the findings of sci-

ence and the applications of engineering are now so directly engaged in the workings of society that professional education for scientists and engineers must include the study of ways in which scientific, technological, social and human elements interact to give shape to society; and the study of such interactions should be done explicitly through the investigation of problems in modern society which are produced by the interaction."

Thus the new College, for which funding is now actively sought, would be "an integrated, cultural force on the campus." — *J.M.*

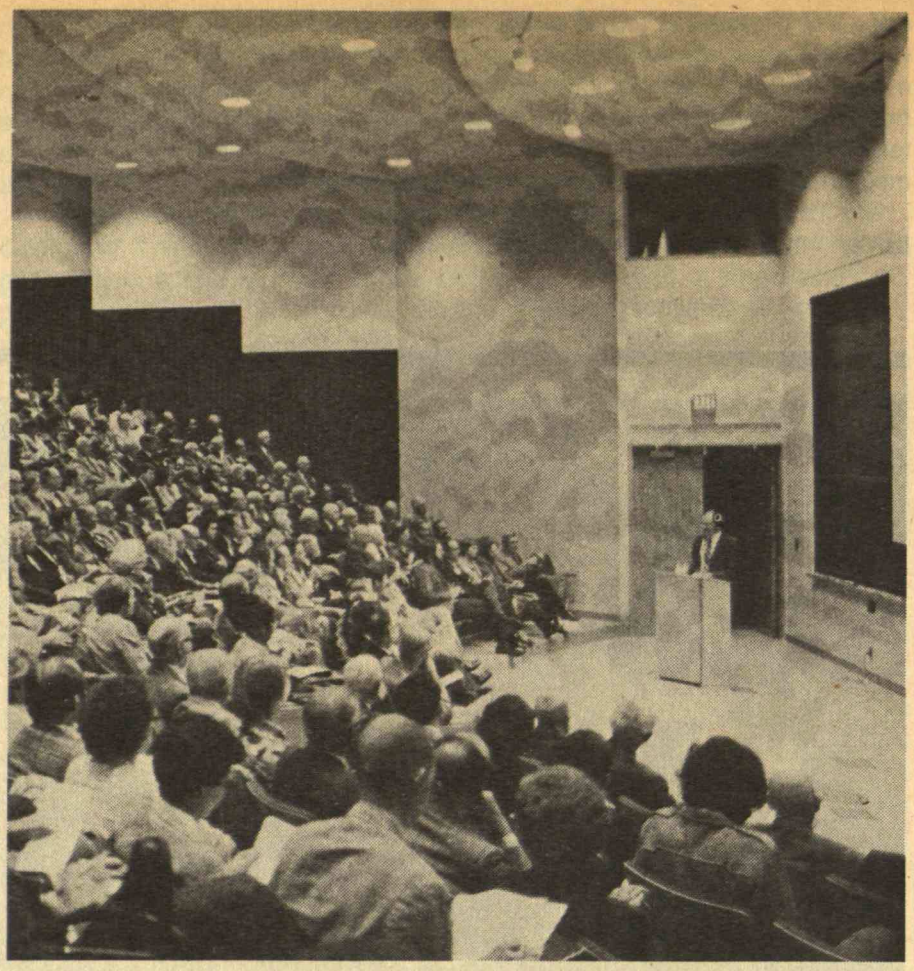
A New Room 10-250, Gallery, Alumni Center, and $542,557 Mortgage Witnessed by 500 Officers

Alumni have had a central role in M.I.T. throughout its 112 years — helping to mold its educational programs, to do its research, to select its students, to employ its graduates, to pay its bills . . .

But there's been no equivalent central presence, no visible symbol or liberal focus of alumni involvement, and that's been a source of increasing concern to the leadership of the Alumni Association.

So there was a moment of special pride for Breene M. Kerr, '51, himself a former President of the Association, when he presented to President Jerome B. Wiesner on October 7 a modernized Room 10-250 and — below it on the first floor of Building 10 — a maze of studs and sheetrock which would soon be transformed into M.I.T.'s first Alumni Center.

To some of over 500 alumni officers and guests in the audience the dedication — it was timed to be a feature of the 1977 Alumni Officers Conference — must have seemed a bit premature. Only $780,000 of the $1.3 million needed to rejuvenate the first two floors of Building 10 was in hand, and only part of the job was finished.



The Alumni Officers' Conference spotlight was on the new Room 10-250 on October 7, when Breene M. Kerr, '51, presented it to President Jerome B. Wiesner at a dedication; and on Frank Press, President Jimmy Carter's Science Adviser, on October 8. Dr. Press is shown at the top with James R. Killian, Jr., '26, the first Presidential Science Adviser, on the steps of Killian Court; he delivered the annual Richards Lecture on October 8. The new Room 10-250 turned out to be a smashing success: new upholstered (in vivid purple) chairs, a big new projection booth, no seats behind pillars, vastly improved acoustics. (Photos here and opposite: Roger N. Goldstein, '72, and Calvin Campbell)

But the new Huntington Hall (it still carries the name of the one classroom in which every one of the Institute's graduates since its founding has heard lectures before finishing an undergraduate degree) was complete; the first exhibit — "The Compton Years" — was in place in the Margaret Hutchinson Compton Gallery on the first floor; and Mr. Kerr confirmed the alumni intentions by giving President Wiesner a mortgage promising payment of $542,557 still due on the job. And he reserves the pleasure, said Mr. Kerr, of burning the mortgage in June, 1978.

The Class of 1938, represented at the ceremony by Norman B. Leventhal, '38, President of the Alumni Association, pledged $100,000 for the Compton Gallery, the full pavment to be made at the time of its 40th reunion in June.

"It's Just Not the Same Any More"

Everyone likes the refurbished — really, rebuilt — Room 10-250. Responding to Mr. Kerr's dedication remarks, President Wiesner said it was nice enough to encourage him to give up the Presidency and return to teaching. Surveying student reaction to lectures in the new room, Steven T. Kirsch, '78, said in *The Tech* that it was "generally favorable." Students' comments: "It's more comfortable . . . easier to fall asleep . . . the acoustics are much better . . . I like the three levels of blackboard . . . not enough leg room on the side . . . writing arms too small . . . no clock . . . the purple (on the seats) isn't that bad."

Alumni attending the dedication were enthusiastic; they agreed with President Wiesner's judgment that it's clearly "the most comfortable hall to bear the name." And they liked his promise that the "same sense of electricity and excitement" which they remembered would still be in the room with its new generations of students and teachers.

A Tree Off the Old Apple. Remember the story (is it apocryphal?) about Sir Isaac Newton's conception of universal gravity after observing an apple fall in his garden? An apple tree said to be descended from Newton's now flourishes at the National Bureau of Standards; and a descendent of *that* tree now resides in the Alumni Center garden behind Building 3 at M.I.T. It all happened at the Alumni Officers' Conference in October, when Edward O. Vetter, '42, presented and planted *(below)* the little tree. It's a memento of his months as Under Secretary of Commerce at the end of President Gerald R. Ford's administration. (Not to be outdone, Breene M. Kerr, '51, Chairman of the committee for the new Alumni Center, presented and planted at the same time an "Oklahoma" redbud tree from his Oklahoma City garden. Of the redbud and the apple, which will flower first?) (Photo: Roger N. Goldstein, '74)

By early in January, alumni returning to M.I.T. will find showy exhibitions and a warm welcome in a new Alumni Center on the first floor of Building 10. Alumni attending the A.O.C. had a preview of the Margaret Hutchinson Compton Gallery, a gift of the Class of 1938, in which was hung an inaugural exhibit on "The Compton Years."

Making an early start on the 50-year reunion gift. Telephones rang across the nation throughout the fall as Alumni Fund workers called on alumni everywhere to help build the 1978 Alumni Fund. In the picture are Mr. and Mrs. Willis F. Tibbets (left), James Donovan (center), and Mr. and Mrs. Walter J. Smith making calls to colleagues in the Class of 1928, preparing for the 50th reunion next June. (Photo: Calvin Campbell)

A Challenge Accepted: $4.8 Million for a Record Alumni Fund

If you increased your gift to the 1977 Alumni Fund by $25 or more over the amount you gave in 1976, M.I.T. received the amount of your increase from a challengers' fund as well as all the money which you yourself gave; and there may in addition have been a gift from your employer to match your giving.

All these incentives added up to a record year for the Alumni Fund: $4,851,160 from 21,125 donors, not including $812,000 which came anonymously because over 9,000 alumni increased their gifts by $25 or more and $300,000 from corporate matching gift programs.

An "overwhelming success," says Paul P. Shepherd, '53, Chairman of the 1976-77 Alumni Fund Board.

Can it be exceeded in 1978?

Thomas H. Farquhar, '60, who heads this year's Alumni Fund Board, thinks so. A new group of anonymous alumni have now issued Challenge 78: they will match, dollar for dollar, increases in gifts of $25 to $1,000 to the 1978 Fund. Gifts of $25 to $1,000 from alumni who did not give at all last year, and gifts of *any* size from members of the classes of 1973 through 1977, will qualify for doubling. A pool of $500,000 is now available.

A 21-Per-Cent Increment on the Way to $6.4 Million

The Alumni Fund is considered an integral part of the $225 million Leadership Campaign, and the Fund's goal within the campaign is $6.4 million of annual giving by 1980. Last year's $4.8 million is 21 per cent above the 1976 Fund total — well on the way to the long-range target.

Just under half of last year's $4.8 million was given without restriction or designation as to use; 15 per cent was designated for student financial aid, 6 per cent for student housing, 23 per cent for departmental purposes, and 11 per cent for other special projects. The Ellen Swallow Richards Professorship received $18,000, the Independent Residence Development Fund $208,500, and the Building 10 Fund (to renew Room 10-250 and provide a new Alumni Center) over $700,000 in gifts and pledges.

How to Double Your Dollars By Having Them Matched

One way to add other people's money to the Alumni Fund when you give your money is to increase your gift and qualify for Challenge funds *(see left)*. Another way is to work for any one of almost 700 U.S. industrial firms with matching gift programs.

Just under $300,000 came to the 1977 Alumni Fund from such companies; each arranges through personnel or community relations offices for payments matching employees' gifts. If you work for any of the companies in the list on the next page, your gift to M.I.T. can do double duty through a corporate gift matching program and — if it's $25 or more than you gave last year — triple duty through the 1977 Challenge.

U.S. Companies Who Will Match Alumni Gifts to M.I.T. With Gifts of Their Own

a
ACF Industries, Inc.
AMAX, Inc.
AMF Inc.
ASARCO, Inc.
Abbott Laboratories
A. S. Abell Co. Foundation, Inc.
Abex Corp.
Aeroglide Corp.
Aerojet-General Corp.
Aetna Insurance Co.
Aetna Life & Casualty
Aid Assn. for Lutherans
Air Products & Chemicals, Inc.
Airco, Inc.
Akzona, Inc.
Alco Standard Corp.
Alexander & Alexander Inc.
Allegheny Ludlum Industries, Inc.
Allendale Mutual Insurance Co.
Allied Chemical Corp.
Allis-Chalmers Corp.
Allstate Insurance
Aluminum Co. of America
American Bank & Trust Co. of Pa.
American Brands, Inc.
American Broadcasting Co., Inc.
American Can Co.
American Credit Corp.
American Express Co.
American Hoechst Corp.
American Homes Products Corp.
American Motors Corp.
American National Bank
American National Bank & Trust Co. of Chicago
American Optical Corp.
American Standard, Inc.
American States Insurance
American Sterilizer Co.
American Stock Exchange, Inc.
American Telephone & Telegraph Co.
American United Life Ins. Co.
Amfac, Inc.
Amstar Corp.
The Anaconda Co.
The Andersons
Arkwright-Boston Manufacturers Mutual Insurance Co.
Armco Steel Corp.
Armstrong Cork Co.
Arrow-Hart, Inc.
Arthur Andersen & Co.
Ashland Oil, Inc.
Associated Box Corp.
Associated Dry Goods Corp.
Athos Steel & Aluminum, Inc.
Atlantic Richfield Co.
Atlas Rigging & Supply Corp.

b
The Badger Co., Inc.
The J. E. Baker Co.
Ball Corp.
Bancroft-Whitney Co.
Bank of America
Bank of California, N.A.
The Bank of New York
The Bankers Life Co.
Barnes & Roche, Inc.
Barnes Group Inc.
Barry Wright Corp.
The Barton-Gillet Co.
Bechtel Foundation
Becton, Dickinson & Co.
Bechtel Foundation
Becktold Co.
Becton, Dickinson & Co.
Bell Federal Savings & Loan Assn.
Bemis Co., Inc.
The Bendix Corp.
Bernd Brecher & Assoc. Inc.
Bethlehem Steel Corp.
James G. Biddle Co.
Blount, Inc.
Blue Bell, Inc.
Boise Cascade Corp.
Borg-Warner Corp.
The Bowery Savings Bank
The Brakeley Co.
Brakeley, John Price Jones, Inc.
Bristol-Myers Co.
Brockway Glass Co., Inc.
Brown-Forman Distillers Corp.
Brunswick Corp.
Buckbee Mears Co.
Buckeye International, Inc.
Buffalo Savings Bank
Bunge Corp.
Bunker-Ramo Corp.
Burlington Industries, Inc.
Burroughs Wellcome Co.
Business Men's Assurance Co. of America

c
CIBA-GEIGY Corp.
C.I.T. Financial Corp.
CNA Financial Corp
CPC International Inc.
Cabot Corp.
Calex Mfg. Co., Inc.
The Callanan Road Improvement Co.
Campbell Soup Co.
Canadian General Electric Co., Ltd.
The Carborundum Co.
Carolina Telephone & Telegraph Co.
Carpenter Technology Corp.
Carrier Corp.
Carter-Wallace, Inc.
Castle & Cooke, Inc.
Cavalier Corp.
Celanese Corp.
Central & South West Corp.
Central Illinois Light Co.
Central Life Assurance Co.
Certain-Teed Products Corp.
Champion International Corp.
Champion Spark Plug Co.
The Chase Manhattan Bank, N.A.
Chemical Bank
Chemtech Industries, Inc.
Chesapeake Corp. of Va.
Chicago Pneumatic Tool Co.
Chicago Title & Trust
Chrysler Corp.
Chubb & Son, Inc.
Citicorp.
Cities Service Co.
The Citizens and Southern Corp.
The Citizens & Southern National Bank
Citizens Fidelity Bank & Trust Co.
Clark Equipment Co.
The Cleveland-Cliffs Iron Co.
Cleveland Electric Illuminating Co.
Cleveland Institute of Electronics
Cleveland Trust Co.
Clow Corp.
Coats & Clark, Inc.
The Coca-Cola Co.
Colgate-Palmolive Co.
Collins & Aikman Corp.
The Colonial Life Ins. Co. of America
Colonial Parking, Inc.
Colonial Penn Group, Inc.
Columbia Gas System, Inc.
The Columbus Mutual Life Ins. Co.
Combustion Engineering Inc.
Commercial Credit Co.
Commercial Union Assurance Co.
Connecticut Bank & Trust Co.
Connecticut General Insurance Corp.
Connecticut Light & Power Co.
Connecticut Mutual Life Insurance Co.
Connecticut Natural Gas Corp.
Consolidated Foods Corp.
Consolidation Coal Co.
Container Corp. of America
The Continental Corp.
The Continental Group, Inc.
Continental Illinois National Bank and Trust Co.
Continental Oil Co.
The Cook Foundation, Inc.
Cooper Industries, Inc.
The Copley Press, Inc.
Copolymer Rubber & Chemical Corp.
Corning Glass Works
Crocker National Bank
Crompton Co. Inc.
Crompton & Knowles Corp.
Crouse-Hinds Co.
Crum & Forster Insurance Co.
Cutler-Hammer, Inc.
Cyprus Mines Corp.

d
Dana Corp.
Dart Industries Inc.
Dayton Malleable Inc.
Deere & Co.
DEKALB AgResearch, Inc.
Del Monte Corp.
DeLuxe Check Printers, Inc.
Deposit Guaranty National Bank
A.W.G. Dewar, Inc.
The Dexter Corp.
Diamond Crystal Salt Co.
Diamond Shamrock Corp.
A.B. Dick Co.
Dickson Electronics Corp.
Difco Laboratories
Digital Equipment Corp.
Dillingham Corp.
Donaldson, Lufkin & Jenrette, Inc.
R. R. Donnelley & Sons Co.
Dow Badische Co.
The Dow Chemical Co.
Dow Corning Corp.
Dresser Industries, Inc.
Wilbur B. Driver Co.
Dun & Bradstreet Co., Inc.

e
E-B Industries, Inc.
ESB Inc.
Earth Resources Co.
Eastern Gas & Fuel Associates
Easton Car & Construction Co.
Eaton Corp.
Educators Mutual Life Insurance
Egan Machinery Co.
Emery Industries, Inc.
Emhart Corp.
Equitable Life Assurance Society of the United States
Equitable of Iowa
Esmark Inc.
Ethicon, Inc.
Ethyl Corp.
Ex-Cell-O Corp.
Exxon Co., U.S.A.
Exxon Corp.

f
FMC Corp.
Factory Mutual Engineering Research Corp.
Fairchild Industries, Inc.
Farm Credit Banks of Springfield
Federal-Mogul Corp.
Federal National Mortgage Association
Federated Department Stores, Inc.
Ferro Corp.
The Fidelity Bank
Fiduciary Trust Co.
Field Enterprises, Inc.
Fireman's Fund American Insurance Co.
Fireman's Mutual Insurance Co.
The Firestone Tire & Rubber Co.
First & Merchants National Bank
First Bank
First Boston Corp.
First Chicago Corp.
First Hawaiian Bank
First National Bank of Boston Corp.
The First National Bank of Miami
First National Bank of Minneapolis
First National Bank of Oregon
The First National Bank of St. Paul
First National Holding Corp.
Fluor Corp.
Ford Motor Co. Fund
Ford Motor Co. of Canada, Ltd.
Forty-Eight Insulations, Inc.
Foster Grant Co., Inc.
Foster Wheeler Corp.
Freeport Minerals Co.
H. B. Fuller Co.
Fulton Federal Savings & Loan Assn.

g
E. & J. Gallo Winery
Frank E. Gannett Newspaper Foundn., Inc.
Gardner Denver Co.
The Gates Rubber Co.
General Cable Corp.
General Dynamics Corp.
General Electric Co.
General Foods Corp.
General Foods, Ltd.
General Mills, Inc.
General Public Utilities Service Corp.
General Reinsurance Corp.
General Telephone & Electronics Corp.
The General Tire & Rubber Co.
Getty Oil Co.
Gibbs & Hill, Inc.
Gilford Instrument Laboratories, Inc.
The Gillette Co.
Girard Trust Bank
Goldman, Sachs & Co.
B. F. Goodrich Co.
Goodyear Tire & Rubber Co.
Gould Inc.
W. R. Grace & Co.
Alexander Grant & Co.
Graphic Arts Mutual Ins. Co.
The Graphic Printing Co., Inc.
Great Northern Nekoosa Corp.
Green Giant Co.
Grinnell Mutual Reinsurance Co.
Griswold-Eshleman Co.
The Guardian Life Ins. Co.
Gulf & Western Industries, Inc.
Gulf Oil Corp.
Gulf States Utilities Co.
The Gurin Group, Inc.

h
Halliburton Co.
John Hancock Mutual Life Ins. Co.
Hanes Corp.
The Hanna Mining Co.
Harper & Row Publishers, Inc.
Harris Corp.
Harris Trust & Savings Bank
Harsco Corp.
Hart, Schaffner & Marx
The Hartford Electric Light Co.
The Hartford Insurance Group
Hartford National Bank and Trust Co.
The Hartford Steam Boiler Inspection & Insurance Co.
Haskins & Sells
Hawaiian Telephone Co.
H. J. Heinz Co.
HERCO, Inc.
Hercules, Inc.
Hershey Foods
Heublein Inc.
Hewlett-Packard Co.
Hill Acme Co.
Hoerner Waldorf Corp.
Hoffman-LaRoche, Inc.
Honeywell, Inc.
Hooker Chemical Corp.
Hooker Chemicals and Plastics Corp.
The Hoover Co.
Geo. A. Hormel & Co.
Houghton Chemical Corp.
Houghton Mifflin Co.
Household Finance Corp.
Houston Natural Gas Corp.
J. M. Huber Corp.
Hufsey-Nicolaides Associates, Inc.
Hughes Aircraft Co.
Huyck Corp.

i
ICI United States, Inc.
INA Corp.
Illinois Bell Telephone Co.
Illinois Tool Works Inc.
Industrial Indemnity Co.
Industrial National Bank of R.I.
Ingersoll-Rand Co.
Inland Container Corp.
Integon Corp.
International Basic Economy Corp.
International Business Machines Corp.
International Flavors & Fragrances
International Minerals & Chemical Corp.
International Multifoods Corp.
International Nickel Co., Inc.
International Paper Co.
International Telephone & Telegraph Corp.
Interpace Corp.
Investors Diversified Services, Inc.
Irving Trust Co.
Itek Corp.

j
JSJ Corp.
The Jefferson Mills, Inc.
Jefferson-Pilot Broadcasting Co.
Jefferson-Pilot Corp.
Jersey Central Power & Light Co.
Jewel Co. Inc.
Johnson & Higgins
Johnson & Johnson
S. C. Johnson & Son, Inc.
R. B. Jones Corp.
Jones & Laughlin Steel Corp.
Josten's, Inc.

k
Kaiser Steel Corp.
Karmazin Products Corp.
Kearney-National Inc.
Keebler Co.
The Kendall Co.
Kennametal, Inc.
Kennecott Copper Corp.
The Kerite Co.
Kern County Land Co.
Kerr-McGee Corp.
Kersting, Brown & Co., Inc.
Walter Kidde & Co.
Kidder, Peabody & Co., Inc.
Kimberly-Clark Corp.
Kingsbury-Machine Tool Corp.
The Kiplinger Washington Editors, Inc.
Richard C. Knight Insurance Agency
Koehring Co.
H. Kohnstamm Co., Inc.
Koppers Co., Inc.
Kraftco Corp.

l
The Lamson & Sessions Co.
Lehigh Portland Cement Co.
Lever Brothers Co.
Levi Strauss & Co.
Liberty Life Insurance Co.
Liggett Group, Inc.
Little, Brown & Co.
Loews Corp.
Louisiana Power & Light
Loyal Protective Life Insurance Co.
The Lubrizol Corp.
Ludlow Corp.
Lukens Steel Co.
C. E. Lummus
Lutheran Mutual Life Ins. Co.

m
M&T Chemicals Inc.
MCA Inc.
MFB Mutual Insurance Co.
Mack Trucks, Inc.
MacLean-Fogg Lock Nut Co.
Mallinckrodt Inc.
P. R. Mallory & Co., Inc.
Manufacturers Hanover Trust Co.
Marathon Oil Co.
Marcor Service Corp.
The Marine Corp. & Subsidiary Banks
Marine Midland Bank
Marmon Group Inc.
Marsh & McLennan Management Co.
Martin Marietta Corp.
Massachusetts Mutual Life Ins. Co.
The Maytag Co.
McCormick & Co., Inc.
McDonald's Corp.
McGraw-Hill, Inc.
Arthur G. McKee & Co.
Meadville Corp.
Medtronic, Inc.
Medusa Corp.
Mellon Bank N.A.
Menasha Corp.
Merck & Co., Inc.
Metropolitan Edison Co.
Metropolitan Life Ins. Co.
Mettler Instrument Corp.
Michigan General Corp.
Middle South Services, Inc.
Middlesex Mutual Assurance Co.
Midland Mutual Life Insurance Co.
Midland-Ross Corp.
Miehle-Goss-Dexter, Inc.
Milliken & Co.
Milton Bradley Co.
Minneapolis Star & Tribune Co.
Minnesota Mining & Manufacturing Co.
The Minnesota Mutual Life Ins. Co.
Mobil Oil Corp.
Mohasco Corp.
Monroe Auto Equipment Co.
Montgomery Ward & Co.
Monumental Corp.
Moog, Inc.
Moreland Chemical Co., Inc.
Morgan Construction Co.
Morgan Guaranty Trust Co. of N.Y.
Motorola, Inc.
Mountain States Mineral Enterprises, Inc.
Munsingwear, Inc.
Murphy Oil Corp.
Mutual Benefit Life Insurance Co.
The Mutual Life Insurance Co. of N.Y.
Mutual of Omaha — United of Omaha

n
N.C.R. Corp.
NL Industries, Inc.
NLT Corp.
Nabisco, Inc.
Nalco Chemical Co.
National Can Corp.
National Central Financial Corp.

National Distillers & Chemical Corp.
National Life Insurance Co.
National Steel Corp.
Nationwide Mutual Insurance Co.
Natomas Co.
New England Gas & Electric Assoc.
New England Merchants National Bank
New England Mutual Life Insurance Co.
New England Petroleum Corp.
New Orleans Public Service Inc.
New York Bank for Savings
The New York Times Co.
The New Yorker Magazine, Inc.
Nordson Corp.
North American Philips Corp.
Northeast Utilities Service Co.
Northern Illinois Gas Co.
Northern Natural Gas Co.
Northern Trust Co.
Northwestern Bell
The Northwestern Mutual Life Ins. Co.
Northwestern National Life Insurance Co.
Norton Co.
W. W. Norton & Co., Inc.
John Nuveen & Co., Inc.

o
Oakite Products, Inc.
Oklahoma Gas & Electric Co.
Old Stone Bank
Olin Corp.
Oneida Ltd.
Ortho Pharmaceutical Corp.
Owens-Corning Fiberglas Corp.
Owens-Illinois, Inc.

p
PPG Industries, Inc.
Pacific Mutual Life Ins. Co.
Pacific Resources Inc.
Panhandle Eastern Pipe Line Co.
Parker-Hannifin Corp.
Ralph M. Parsons Co.
Peat, Marwick, Mitchell & Co.
Pechiney Ugine Kuhlmann Corp.
J. C. Penney Co.
Pennsylvania Electric Co.
Pennsylvania Power & Light Co.
Pennwalt Corp.
Pennzoil Co.
Petro-Tex Chemical Corp.
Pfizer, Inc.
Phelps Dodge Corp.
Philadelphia Quartz Co.
Philip Morris Inc.
Phillips Petroleum Co.
Phoenix Mutual Life Insurance Co.
Pickands Mather & Co.
The Pillsbury Co.
Pitney Bowes, Inc.
Pittsburgh National Corp.
Plainfield Cytology Laboratory, Inc.
Polaroid Corp.
Potlatch Corp.
Preformed Line Products Co.
Prentice-Hall, Inc.
Price Brothers Co.
Price Waterhouse & Co.
Provident Life & Accident Ins. Co.
Provident Mutual Life Insurance Co. of Philadelphia
Provident National Bank
The Prudential Insurance Co. of America
Pullman Inc.

q
Quaker Chemical Corp.
The Quaker Oats Co.
Quaker State Oil Refining Corp.

r
Ralston Purina Co.
Rand McNally & Co.
Raytheon Co.
Reliance Electric Co.
Reliance Insurance Co.
Rexham Corp.
Rexnord, Inc.
R. J. Reynolds Industries, Inc.
Rich's Inc.
Richardson, Gordon & Associates
Richardson-Merrell, Inc.
Riegel Textile Corp.
Rochester Germicide Co.
The Rockefeller Brothers Fund, Inc.
Rockefeller Family & Associates
The Martha Baird Rockefeller Fund for Music, Inc.
Rockwell International Corp.
Rohm & Haas Co.
ROLM Corp.
Royal Globe Insurance Cos.
Arthur Rudick Brokerage
Rust Engineering Co.

s
SCM Corp.
SKF Industries
St. Joe Minerals Corp.
St. Regis Paper Co.
Salomon Brothers
Sanders Associates, Inc.
Sandoz, Inc.
Schering-Plough Corp.
The Schlegal Corp.
Scott Paper Co.
Joseph E. Seagram & Sons, Inc.
Sealright Co., Inc.
G. D. Searle & Co.
Seattle-First National Bank
Security Pacific Corp.
Security Van Lines, Inc.
Seton Co.
Shenandoah Life Ins. Co.
The Sherwin-Williams Co.
Shulton, Inc.
The Signal Co., Inc.
Signode Corp.
Silver Burdett Co.
Simmons Co.
The Singer Co.
Skelly Oil Co.
SmithKline Corp.
Sony Corp. of America
Southeast Banking Corp.
Southeast First Bank of Jacksonville
Southern Natural Gas Co.
Southern New England Telephone
The Southland Corp.
Southwestern Bell Telephone Co.
The Sperry & Hutchinson Co.
Spruce Falls Power & Paper Co.
The Square D Co.
Squibb Corp.
Stackpole Carbon Co.
Stanadyne, Inc.
Standard Oil Co. (Indiana)
The Standard Oil Co. (Ohio)
Standard Oil Co. of California
Standard Pressed Steel Co.
The Stanley Works
State Mutual Life Assurance Co. of Am.
Stauffer Chemical Co.
Steel Heddle Mfg. Co.
Sterling Drug, Inc.
J. P. Stevens & Co., Inc.
Stone & Webster, Inc.
Suburban Propane Gas Corp.
Sunlife Assurance Co. of Canada
Sun Co., Inc.
Sybron Corp.
Syntex Corp.

t
TRW Inc.
Tektronix, Inc.
Teledyne, Inc.
Tennant Co.
C. Tennant, Sons & Co. of N.Y.
Tenneco, Inc.
Texas Eastern Transmission Corp.
Texas Instruments Inc.
Texasgulf, Inc.
Textron, Inc.
The Thomas & Betts Corp.
J. Walter Thompson Co.
J. T. Thorpe Co.
Tiger Leasing Group
Time, Inc.
The Times Mirror Co.
Times Publishing Co. & Congressional Quarterly
The Torrington Co.
Towers, Perrin, Forster & Crosby, Inc.
Tracor, Inc.
Transamerica Corp.
The Travelers Insurance Co.
Treadway Co., Inc.
Trust Co. of Georgia
Turner Construction Co.

u
Union Camp Corp.
Union Commerce Bank
Union Electric Co.
Union Oil Co. of California
Union Pacific Corp.
Uniroyal, Inc.
United Bank of Denver
United Brands Co.
United California Bank
United Energy Resources Inc.
United Engineers & Constructors, Inc.
United Life & Accident Insurance Co.
United Parcel Service
United States Borax & Chemical Corp.
United States Tobacco Co.
United States Trust Co. of N.Y.
United Technologies Corp.
United Virginia Bank Shares Inc.
The Upjohn Co.
Urban Investment and Development Co.
Utah International Inc.
Utica National Insurance Group

v
Varian Associates
Victaulic Co. of America
Vulcan Materials Co.

w
Wallace-Murray Corp.
The Wallingford Steel Co.
Warnaco
Warner-Lambert Co.
Warner & Swasey Co.
Washington National Insurance Co.
Washington Post
Watkins-Johnson Co.
C. J. Webb, Inc.
Weeden & Co.
Welch Foods, Inc.
Wellington Management Co.
Wells Fargo & Co.
West Point Pepperell
West Sand & Gravel Co., Inc.
Western Publishing Co., Inc.
Westinghouse Electric Corp.
Westvaco Corp.
Weyerhaeuser Co.
Whirlpool Corp.
White Motor Corp.
Wickes Corp.
John Wiley & Sons, Inc.
Williamette Industries, Inc.
Williams & Co.
Winn-Dixie Stores, Inc.
Wisconsin Telephone Co.
Wolverine World Wide, Inc.
BASF Wyandotte Corp.

x
Xerox Corp.

y
Arthur Young and Co.
William E. Young & Co.
Young & Rubicam International, Inc.

Twenty years after the launching of Sputnik, the M.I.T. Press published Sputnik, Scientists, and Eisenhower: A Memoir of the First Special Assistant to the President for Science and Technology, *by James R. Killian, Jr. Drawn from Dr. Killian's recollections and from recently declassified materials in the Eisenhower Library, it gives the reader insight into what it was like to shape national policy in the crucial days between McCarthyism and the '60s. President Jerome B. Wiesner (right) is with Dr. Killian at a party celebrating the publication.*

James R. Killian, Jr., '26: Recollections

While attention is focused on James R. Killian, Jr., '26, as the author of *Sputnik, Scientists, and Eisenhower* (see pages 9-11), I decided to ask him about other recollections of times past, his thoughts on M.I.T. after more than 50 years on the campus, and his involvements now. It was the first time I had met Dr. Killian with time to sit and talk — and I was nervous. But I was put at ease immediately by his shy, quiet, elegant manner. His eyes sparkled as he remembered favorite times. Here he is, paraphrased:

On M.I.T.:

"My wife and I have laughed at how difficult it is to travel incognito when one is associated with M.I.T."

Someone has said M.I.T. is a map of the intellectual life of our times. The fact that we have steadily added to the strength of the Institute in the physical and intellectual sense means that M.I.T. is at a peak of influence now.

Over a long period the M.I.T. degree has been held in high esteem; certainly it is just as highly regarded today as in the past. It has been viewed as providing graduates with an unusually good opportunity to succeed in the careers of their choice.

M.I.T. is better known abroad than at home; it is hard to explain that fully. Perhaps because we've been very hospitable to foreign students; and the coalition of disciplines here is particularly attractive to them. And M.I.T.'s early achievement as an institute of excellence created a great interest around the world. My wife and I have laughed at how difficult it is to travel incognito when one is associated with M.I.T.

I have always found M.I.T. to be extremely stimulating — a warm and friendly place. I find it hard to see why some say it is cold and factory-like. During my entire career here it has been a great privilege to have warm, rewarding friendships completely apart from official activities.

On especially exciting times:

Moving into World War II, the war itself, and the renewal and reconstruction afterwards were extraordinarily stimulating experiences. M.I.T. was serving the country during the war — the Radiation Laboratory, for instance, had 4,000 people. As we came out of the war, we rebuilt undergraduate and graduate study at the Institute (which had been greatly curtailed during the war). There were many innovations: M.I.T. was the first institution to create housing for married war veterans. We started vigorously recruiting students around the country to get studies going in all fields of graduate study. We established new interdisciplinary studies. The Research Laboratory of Elec-

tronics was a pioneering venture and set a new pattern for interdisciplinary education and research. We recruited a number of new members for the faculty including some we had come to know during the war and a number from the Radiation Laboratory who were to become distinguished. It was an extraordinary period — a sense of the Institute moving into a new context, a new phase, with widened reach and opportunities.

We made greater use of government funds than we ever had in the past. This great involvement in government-sponsored research continues today and has profoundly strengthened M.I.T., even though we must now struggle to prevent undue government restraints on our freedom.

We undertook many novel studies in behalf of national security. The "summer study" projects were invented here. "Project Troy," for example, was sponsored by the State Department, designed to find ways of enabling the Voice of America to reach behind the Iron Curtain. This brought together in unusual partnership social scientists and engineers. After the project was finished, they came to me and urged M.I.T. to perpetuate such interdisciplinary activities. We did that by establishing the Center for International Studies.

On particularly rewarding endeavors:
I found it rewarding and exciting to work in the field of curriculum reform and development in high schools. Beginning in 1955 Professor Jerrold R. Zacharias embarked on innovative ways to strengthen science teaching in secondary schools. This led to the development of a famous new course in physics for high school students, and a text book was written which was to sell over a million copies in the United States and half again as many overseas. Thus M.I.T. became recognized as a leader in curriculum reform for pre-college schools. Later, other institutions undertook pre-college programs in biology and mathematics. Now Professor Zacharias is completing a new TV course for the teaching of mathematics.

The fact that I've had an opportunity to run interference for such a group of innovative scientists on such important endeavors has been satisfying and rewarding and good fun, too.

On current activities:
Now I am lending a hand to the Leadership Campaign and am engaged in a variety of extracurricular activities. At present, Professor Edgerton and I are working on new material for a book on strobe photography that I helped him with originally in 1939, called *Flash.*

I'm still interested in various enterprises that relate to the federal government, science, and universities. A new committee has been appointed to study the relationship of the federal government to universities, and I have agreed to devote time to that.

On summing up:
In addition to work at M.I.T., I take satisfaction from three major undertakings I've been involved in: the curriculum reform movement; the furtherance of public television; and science advice at the level of the White House (which took me away from M.I.T. for 20 months, including the memorable experience of working with President Eisenhower).

I've had an exciting and immensely stimulating life. My effectiveness has been far greater because I had the aura of M.I.T. around me, and I look back with a sense of having been able to engage in important national and international enterprises while — I hope — contributing to the greatness of M.I.T. — *M.L.*

If Washington Seems Into Everything, Relax and Enjoy

Since 1900, American business has replaced the American negro as the principal object of national discrimination, says Paul A. Samuelson, Professor of Economics at M.I.T.

Will the trend toward government intervening into corporate decision-making and assuming functions previously assigned to private enterprise continue? It will — for a while, says Professor Samuelson. Ours is now a mixed economy — neither truly capitalist nor wholly socialist, about 30-60 in terms of government-vs.-private employment. By the end of the century government may claim half of our national energies, he says — a way of describing further inroads into corporate management and executive decision-making.

But there the trend will end. After government has absorbed another 15 to 20 per cent of our total national effort, says Professor Samuelson, a new equilibrium will assert itself because Americans still have a fundamental distrust of socialism. That's why, even now, the private sector is "more vigorous in the U.S. than anywhere else in the world," says Professor Charles A. Myers.

Edgar H. Twine, S.M. '73, Associate General Counsel of Atlantic Richfield Co., is not so sure. Government agencies tend to self-perpetuate and even expand their regulatory roles, he says. It's a simple "snowballing" process: agencies add ever more new regulations under congressional mandates; then they have to develop new enforcement initiatives; then must come more new regulations, and then more enforcement . . . an unending chain of ever-growing government involvement.

How does (and will) business respond to growing intervention into its affairs — or infringement upon its prerogatives, if you prefer? There was no monolithic answer from alumni of the Sloan and Senior Executives Programs of the Sloan School of Management at M.I.T. this fall when some 400 of them returned for a convocation on September 16 and 17. In addition to Professor

Samuelson's keynote statement, there were a panel and a series of smaller discussions on the theme of changing business-government relationships. On September 17 the alumni returned to the familiar Sloan Building classrooms for sessions with Sloan School faculty; the visitors contributed at least as much as the faculty by adding current and pragmatic views to the theory and research upon which the faculty chiefly drew.

Fellowship and learning for 400 alumni of the Sloan School's Executive Development Programs in Cambridge on September 16 and 17. Opening the convocation on "The Changing Relationship Between Business and Government" (opposite, above), Professor Paul A. Samuelson was at once pessimistic and optimistic: though our economy may be 50-50 private-government by 2000, "Americans still have a fundamental distrust of socialism," he said. (Photos: Bradford F. Herzog)

Needed: The Technological Facts of Life

Professor Myers, whose esteem among the Sloan Fellows has led to his holding the Sloan Fellows Professorship, pointed out that some sectors of industry welcome government intervention — indeed, truckers and airline executives say a free, uncontrolled market would lead their businesses into chaos. Too often, he thinks, unwanted regulation has been the result of "simplistic thinking about complicated issues," and it tends in any event to foster such thinking.

Other complaints about regulation poured forth when the alumni had their turn: a "cocoon created to isolate the consumer from business," said Edward E. Barr, President of Sun Chemical Corp. Government environmental regulations began for the best of reasons, he admitted: the free market evaluated clean air and water as free goods, and the public did not agree. But now government regulation has exceeded government's capacity and competence to regulate, and no one knows what will be the consequences.

Government needs to be reminded occasionally that it is the largest nonproductive beneficiary of business acumen, said Richard L. Terrell, Vice Chairman of the Board of General Motors. Stockholders invest $100 to earn $5 in dividends while government invests nothing and claims three times that much income in taxes. And meanwhile, government mandates a major investment — $1.1 billion a year since 1974 in the case of General Motors — to bring industry into compliance with existing and anticipated regulations. That's an out-of-pocket figure which doesn't include the time and effort of "our very best research and management people" or the cost of business opportunities lost due to preoccupation with regulatory business.

Among those present for a day-long study of business-goverment relationships (top to bottom, above): Don N. Stitt, S.M. '65, General Manager of Powers Fiat Corp., and Howard W. Johnson, Chairman of the M.I.T. Corporation; James M. Osborne, S.M. '62, Vice President of RCA, and E. Pennell Brooks, '17, Dean Emeritus of the Sloan School; and Roland B. Butterfield, Jr., S.M. '63, General Manager of Shreveport Works of Western Electric Co., with Peter P. Gil, Associate Dean. (Photos: Bradford F. Herzog)

Another problem, proposed by Willis S. White, Jr., S.M. '58, Chairman of the Board of American Electric Power Co., Inc.: governmental thrusts are on a four-year cycle, each election year bringing the possibility of new decisions and interpretations. But — at least in his industry — technical decisions have a life span of 20 to 50 years. Too often today there's a stand-off between industry that wants a 50-year commitment and government that can't make more than a four-year guarantee; the breeder reactor may be the most obvious case in point.

The universities, too, have their troubles with government regulation, said Professor Walter A. Rosenblith, Provost of M.I.T., as luncheon speaker. It all began with the Morrill Act, giving land-grant institutions special responsibilities and opportunities in agriculture and engineering. Now proliferating requirements and regulations risk a confrontation between academic institutions, which by definition must be imaginative and intellectually mobile, and government, whose concerns are more pragmatic and political.

On the other side of the argument, Mr. Twine reminded his fellow alumni that government is only the collective voice of the people in the U.S. We may castigate Congress for some of its acts, but it is hardly possible in our democracy that the signals which customers send to industry can be so very different from those which voters send to legislators. The real difficulties, he thinks, are at the level of language and implementation: the rigid language of the law is hardly suited for interpreting the complex technical issues now at stake in air and water quality control, for example; and regulators themselves know too little of these technological facts of life.

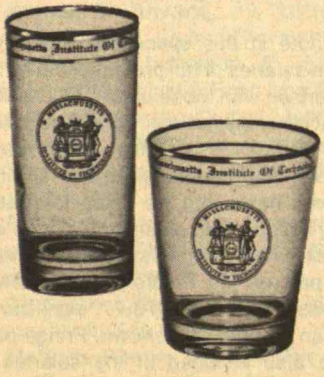
Washington Is Here to Stay

What of the future? More of the same pushing and pulling between and among the forces of industry and government, said Professor Samuelson. It's too simplistic to say that business can avoid the threat of further regulation by more successful efforts to put its house in order. Future confrontations and litigation can hardly be written off that way: consider the plight of a tobacco company executive, whose most obvious response to government pressure is simply unthinkable; his job is to increase, not shut down, his stockholders' tobacco business.

Professor Samuelson's advice to his audience of corporate executives: remember that what government does is not simply the result of bureaucrats feathering their nests; it represents "how we choose to organize our national household." Or, in the words of Wayne L. Horvitz, S.M. '53, it's time for business to abandon the "Washington be damned," "Washington can be bought," and "Washington can be ignored" models. Let's all understand, he said, that "Washington is here to stay" and — given that understanding — seek new ways for positive interaction in responsible behavior on both sides of the equation. — *J.M.*

M.I.T. INSIGNIA

A GOOD WAY TO REMEMBER



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The New West Campus Houses: Four Entries Now Have Names

Burton . . . Baker . . . Walcott . . . Tang . . . Bemis . . .

Soon enough these names have achieved common usage in the special language of the M.I.T. campus.

Now there are four new names to get used to: Ballard, Coolidge, Desmond and Lawrence. These names, those of four major benefactors, were given to four of the six houses in what is still referred to as the New West Campus Houses — the complex between MacGregor and Tang which was completed in September, 1975 — at ceremonies on October 7. Representatives of the four donors as well as many members of the Corporation were present for the afternoon dedication, and the donors were entertained by residents of their houses for the evening.

It used to be House 2; now it's Ballard, in honor of Jonathan and Blanche Ballard of Ft. Worth, Texas. Mr. Ballard graduated from M.I.T. in Business and Engineering Administration with the Class of 1923; he entered the family ice business and then went to larger managerial responsibilities with Southwest Dairy Products Co., and finally the Southland Corp., of which he continues as Director following retirement in 1973.

House 3 is named in honor of William A. Coolidge, who has had a varied career in science and management following graduation from Harvard (A.B. 1924), Harvard Law School (L.L.B. 1926), and Oxford (M.A. 1927). Mr. Coolidge has been a member of the M.I.T. Corporation since 1948.

The late Thomas C. Desmond, '09, was New York State Senator from 1931 until retirement in 1959, representing the Orange-Rockland District; earlier he had made a successful career in engineering and contracting in New York City. He died in 1972, having been a member of the M.I.T. Corporation for 37 years; and now his many benefactions and longtime interest in the Institute are memoralized by naming House 5 in Mr. Desmond's honor. Mr. Desmond's widow, Mrs. Alice Desmond Fish, was present at the ceremony.

House 4 is now named in honor of the late Leonard D. Lawrence, '29, First Vice President of the Bostitch Co., a family firm to which he devoted most of his energies even before graduating from M.I.T. Mr. Lawrence provided generously for M.I.T. in his will, and following his death his unrestricted benefactions were used for — among other purposes — construction of the New West Campus Houses.

The dedication ceremony gave Chancellor Paul E. Gray, '54, a chance to confirm his confidence in and commitment to M.I.T. dormitories and fraternities, in which some 70 per cent of all undergraduates now live. This year's over-crowding, he said, is a tribute to the success of the residential system — even under present conditions, there is a brisk demand for spaces. Dr. Carola Eisenberg, Dean for Student Affairs, emphasized her pride in the role of students in managing and governing the system. Even overcrowding has a silver lining, she said — helping to provide students with experience in managing a democratic system confronted with constraints and shortages.

After Three Deficit Years, Revenues and Expenses Balance: "Cautious Optimism"

M.I.T.'s total operating expenses in 1976-77 were $276.9 million, up 2.8 per cent from the previous year. Revenues and funds specifically designated to meet these expenses were $271.1 million, up 3.2 per cent. The difference of $5.8 million was almost precisely the amount of available unrestricted resources in 1976-77; thus — for the first time in four years — total operating revenues and expenses were in "nominal balance" in the year which ended last June.

Eliminating the persistent deficit between operating revenues and expenses was a formidable achievement, attained a year earlier than M.I.T.'s administration had dared promise a year or more ago. It's the result of increases in current giving, improvements in research volumes and reimbursements, and "close attention to cost control" throughout M.I.T., say President Jerome B. Wiesner and Chancellor Paul E. Gray, '54, in their 1977 annual report.

Here are some details of M.I.T. financial operations in 1976-77 as summarized by Stuart H. Cowen, Vice President for Financial Operations, and Glenn P. Strehle, '58, Treasurer, in the 1977 Treasurer's Report:

- ☐ There was a "substantial drop" in subcontracts and purchased materials and services at Lincoln Laboratory; excluding these items, M.I.T. expenses increased by 5.6 per cent and revenues by 6.1 per cent in 1976-77.
- ☐ Receipts from the Industrial Liaison Program grew "dramatically" — from $1.48 million in 1975-76 to $2.3 million in 1976-77.
- ☐ Unrestricted gifts, grants, and bequests were $3.7 million in 1976-77 compared with $2.2 million the previous year; total giving to the Institute increased even more substantially: from $22.4 million in 1975-76 to $26.9 million in 1976-77.
- ☐ Total funds were 359.4 million on June 30, 1977, compared with $349.6 million a year earlier.
- ☐ There was a "modest" increase of $90,000 in the market value of the Institute's investment portfolio in 1976-77. Common stock prices were down, but prices of fixed-income securities were up; income from common stock dividends was up 27.9 per cent.

Messrs. Cowen and Strehle write of "cautious optimism" for the future. They note that "budget reductions continued to be a way of life, and an attitude of general restraint and cooperation existed throughout the Institute"; but they emphasize that "the problem of keeping ahead of inflation is long term and has no simple solution."

Professors' Earnings: a Clarification

A brief note in this space last month reported on salaries of full professors at M.I.T. in comparison with those of similarly ranked faculty at other institutions, figures compiled by the American Association of University Professors. The figures given are all on a nine-month basis, but we failed to specify that they include both salary and a cash valuation of fringe benefits; annual "take-home" pay of M.I.T. professors (before taxes) was $28,900 in 1976-77, significantly lower than the $34,500 shown. Fringe benefits are also included in the salaries at other institutions which we cited.

Thirteen proud winners of Bronze Beavers pose at the Awards Luncheon during the Alumni Officers' Conference. Left to right: (front) James K. Littwitz, '42, Marjorie Pierce, '22, Floyd A. Lyon, '42, Alfred C. Wu, '40, and L. Kenneth Rosett, '42; (rear) Frederick G. Lehmann, Jr., '51, Charles K. Holmes, Jr., '49, Christian J. Matthew, '43, Peter C. Hand, '48, Norman R. Klivans, '40, Kenneth S. Brock, '48, Edward O. Vetter, '42, and Dwight C. Arnold, '27. Walter A. Rosenblith, Provost of M.I.T. — the fourteenth 1977 Bronze Beaver winner — missed the picture. (Photo: Roger N. Goldstein, '74)

Fourteen Beavers, Three Citations, And a Very Special Paul Revere Bowl

Fourteen Bronze Beaver Awards, three Presidential Citations, and one special Resolution were handed out by Norman C. Leventhal, '38, President of the Alumni Association, during the annual Awards Luncheon at the Alumni Officers Conference on October 8. It was the longest roster of award-winners in the history of the event.

Bronze Beavers, symbolic of the highest award for service to the Alumni Association and M.I.T., were given to

☐ **Dwight C. Arnold,** '27, past President of the Alumni Association and former member of the Corporation.

☐ **Kenneth S. Brock,** '48, former Director of the Alumni Fund and Director of Resource Operations.

☐ **Peter C. Hand,** '48, Director of the First (1968) and Second (1977) M.I.T. Florida Festivals.

☐ **Charles K. Holmes, Jr.,** '49, for "outstanding" alumni leadership in San Francisco, Dallas, Atlanta, and now Concord, Mass.

☐ **Norman R. Klivans,** '40, former President of the M.I.T. Club of Cleveland.

☐ **Frederick G. Lehmann, Jr.,** '51, former Director of the Alumni Fund and Financial Vice President of the Alumni Association.

☐ **James K. Littwitz,** '42, a leader in Club, Fund, and Educational Council activities in Rochester, N.Y.

☐ **Floyd A. Lyon,** '42, Director of the Alumni Center of New York and Estate Secretary for the Class of 1942.

☐ **Christian J. Matthew,** '43, alumni activities leader in San Francisco.

☐ **Marjorie Pierce,** '22, an active member and officer of the Association of M.I.T. Alumnae.

☐ **Walter A. Rosenblith,** Provost of M.I.T.

☐ **L. Kenneth Rosett,** '42, Governor of the Alumni Center of New York, and Secretary of the Class of 1942, and Chairman of the Educational Council in Westchester, New York.

☐ **Edward O. Vetter,** '42, former President of the Alumni Association and Co-Chairman of the M.I.T. Leadership Campaign.

☐ **Alfred C. Wu,** '40, Director of the Alumni Center of New York and member of the Council on the Arts at M.I.T.

There were three Presidential Citations:

☐ For the Symposium on the Management of Innovation conducted by the Alumni Center of New York in December, 1976, under the Co-Chairmanship of **Myron A. Exelbert,** S.M. '63, and **Karl F. Milde, Jr.,** '61.

☐ For alumni in Florida, cooperating to assure the success of Second M.I.T. Florida Festival in February, 1977.

☐ For the M.I.T. Club of Southern California, sponsors during 1976-77 of a showing of "The World of Jefferson and Franklin" and a seminar on "Energy to the Year 2000."

And finally there was a resolution for **Harold E. Edgerton,** Sc.D. '31, Institute Professor, Emeritus. "During his 50 years of 'alumnihood,' " it said, " 'Doc' has carried forward the intellectual excitement of M.I.T. In his special style and with his extraordinary enthusiasm, he has excited thousands of alumni with the wonders of engineering and science." The Awards Lunchon audience responded with a standing ovation when Mr. Leventhal reached for a Paul Revere bowl to symbolize the Association's affection for and indebtedness to a uniquely popular member of the faculty.

Alumni voted Professor Harold E. Edgerton, Sc.D. '31, the most popular member of the M.I.T. faculty by giving him a standing ovation at the Awards Luncheon on October 8. Norman B. Leventhal, '38, President of the Alumni Association, had just given "Doc" the Paul Revere bowl for his efforts to "carry forward the intellectual excitement of M.I.T." (Photos: Roger N. Goldstein, '72)

As the time neared to christen M.I.T.'s new oceanographic research vessel in his honor, Professor Harold E. Edgerton, Sc.D.'31, made plans to capture the moment on film. When the bottle of champagne wielded by Mrs. Edgerton struck the vessel, an inertial contactor triggered a camera and strobe light to make a 1/1,000-second exposure during a 1/10,000-second strobe flash. Dean A. Horn, N.E.'49, Director the Sea Grant Program, is in the center.

Sea Grant Christens the R/V Edgerton

A 65-foot, 90-ton research vessel, formerly a U.S. Army T-Boat, T-424, is now in service for the M.I.T. Sea Grant Program; it's the *R/V Edgerton,* named — of course — for Professor Harold E. Edgerton, Sc.D.'31, whose innovations in underwater cameras and sonars have been so important for ocean exploration.

The T-424 was found in Charleston, S.C., in 1974 by Arthur B. Clifton, Marine Liaison Officer for the Sea Grant Program. He helped bring the T-424 to New England under its own power, and he led a conversion design study by three M.I.T. students working in a special project for Kevin J. O'Toole, N.E. '57, Professor of Naval Architecture. The conversion included adding auxiliary electric generating capacity, lifting equipment fore and aft, laboratory space in a deckhouse and below, and an all-weather internal passageway.

Professor Alfred A. H. Keil, former Dean of the School of Engineering, says the *R/V Edgerton* "marks the beginning of a new era of marine research at M.I.T. . . . will greatly enhance the research effort in coastal waters and the continental shelf."

A Phone In Every Room — at $17.85 a Year

Centrex phone service in a Harvard dormitory is said to cost a bit over $100 a year; students at Yale pay just under $85 a year for a private telephone in a dormitory room.

At M.I.T. the charge, added automatically to dormitory room rents, is $17.85 a year, and every room in every Institute House has a telephone.

A rare bargain when the price of almost everything at M.I.T. is high — and going up.

Telephones in M.I.T. Houses connect to the private "Dorm Line" system. Most of its major equipment was given to the Institute when declared surplus by telephone companies over the years, beginning in 1926, and the job of maintaining it is now in the hands of students who are part-time employees of the Telecommunications Office in the Physical Plant Department.

Though the student staff members cherish their "hands-on" experience with an actual operating system, they face some special problems, too — only some of which are occasioned by the age of the switching equipment with which they work. Peak loads occur not during business hours but between 11 and 12 in the evening. And inbound and outbound don't match: the heaviest inbound calling is to the coeds in McCormick, the heaviest outbound pattern from Bexley Hall.

Hacking presents another special maintenance challenge. During Residence/Orientation Week it fell to Edward Hunter, '79, of the repair team to remove a D.U. banner from a radio mast atop the Student Center. And when Kenneth Hamilton '81, wrote his account of the Dorm Line system for *The Tech* this fall, an "interconnect key system" was in operation somewhere in East Campus. It was providing unlimited access to outside lines for lucky correspondents who could call anywhere in Boston — and perhaps in the U.S. There was an intercom system on the side, equipped with such exotic features as music on "hold."

Working for the C.I.A. Without Knowing It

It's now clear that M.I.T. was among perhaps 80 colleges and universities used — and perhaps compromised — by the Central Intelligence Agency in the 1950s and 1960s, mostly under a project codenamed MK ULTRA to study the reaction of humans to brainwashing by foreign ideologies.

At least two M.I.T. cases have come to light as a result of C.I.A. initiatives to inform universities of covert participation:

☐ From 1950 to 1956, while he was a Captain in the U.S. Army assigned to Walter Reed Hospital, Edgar H. Schein, Professor of Organizational Psychology and Management in the Sloan School of Management, interviewed servicemen who had been prisoners of war in Korea. Then he joined the M.I.T. faculty and — with a $35,000 grant which turns out to have been

from the C.I.A. — he consolidated his findings and wrote *Coercive Persuasion*, which soon became the definitive text on the brainwashing of Korean prisoners of war; the book was published by W. W. Norton and Co., Inc., in 1961.

☐ Anthony J. Wiener came to M.I.T. in 1958 for one year as a guest of the Center for International Studies; by 1959 he had moved on to work with Herman Kahn at the Hudson Institute. His research during the year at M.I.T. was to study how Soviet scientists responded to the conflicting demands of Soviet ideology and the value system of science. The entire expenses were covered by a $12,000 grant made directly to Dr. Wiener from the Society for the Investigation of Human Ecology.

Early this fall the *Chicago Sun-Times* identified the Society for the Investigation of Human Ecology as a front established by the Central Intelligence Agency to cover its research under MK-ULTRA. A C.I.A. memorandum says the real purpose of Dr. Wiener's research was to seek "the most effective way or ways in which repressed and rationalized antiregime motivations may be aroused or, more properly, reactivated" among Soviet scientists. The C.I.A. wanted "to sharpen our sights and methods as respects the spotting, development, and recruitment of selected types of (Soviet) citizens."

Dr. Wiener, now a consultant living in Croton-on-Hudson, N.Y., knew nothing about Project MK-ULTRA or of a connection between the C.I.A. and the Society for the Investigation of Human Ecology. "If all of this is true," he told the *Sun-Times*, "the C.I.A. certainly did not get its money's worth from that study. My conclusions were that Soviet scientists were dedicated, well rewarded, and loyal." Dr. Weiner is angry at the revelation: "I feel I've been done an injury, personally, by the C.I.A., he told Jo Thomas of the *New York Times* this fall. "I would not have lent myself to any kind of deception, and I don't think they should have practiced any sort of deception on me."

Fraternities: Successful Rush, Full Houses

Fraternities are full and prospering after what everyone agrees was a "very good rush" early in the fall. High rents and housing shortages in Boston and Cambridge, plus the prospect of serious overcrowding in the Institute Houses, encouraged members of the Class of 1981 to take the prospect of fraternity living very seriously.

As of the end of September, 399 freshmen were pledged to fraternities — just six short of the 405-pledge goal set by the Interfraternity Conference. Some houses were filled before they could issue invitations to all the members of the Class of 1981 they hoped to pledge. A review of Residence/Orientation Week activities showed that only 110 freshmen out of more than 1,075 failed to visit any fraternities.

Rushing competition was high in September — a situation that could have created bad feelings among fraternities and between fraternities and Institute Houses. That didn't happen, and Steven J. Piet, '78, told Barbara J. Hill, '80, of *The Tech*, "I saw a lot more cooperation between the houses this year." Milton Roye, '78, I.F.C.'s Rush Chairman, says everything went "very smoothly."

Freshmen Quiz: "Everyone Has Fun at No One's Expense"

"Write a short essay comparing Tech and Hell. (Keep in mind that you can't be kicked out of Hell.)"

Not a typical exam. But the Freshman Quiz (students are given an hour to answer about 30 questions) is only supposed to *appear* typical. Freshmen remain serious for a limited amount of time, then gain momentum answering with appropriate creativity. Some questions are impossible, others require knowledge to fashion a humorous answer to what looks like a serious query.

Sample — "Translate the following into a limerick:

$$\frac{12 + 144 + 20 + 3\sqrt{4} + 5 \cdot 11 = 9^2 + 0.}{7}$$

One student's answer:

"A dozen, a gross, plus a score
Plus three times the square root of four
Divided by seven
Plus five times eleven
Is nine square and not abit more."

Other questions include the identification of pseudo chemical compounds, questions about the Institute in general, and the Boston area.

The Freshmen Rules Committee is responsible — a group that rises from the ashes like the phoenix during the summer, administers the quiz, and promptly disappears.

It started four years ago, when Debra P. Deutsch, '75, and friends decided to make up a quiz, then consisting mainly of in jokes and snide comments. "I was reading old Voodoos," says Ms. Deutsch, "and saw the F.R.C. of 1926. Why not revive the committee for the purpose of selling beanies? The money from the beanies is used to help finance the quiz."

It was then (when 125 unsuspecting victims showed up) only a matter of four to five minutes before someone caught on, and in 30 seconds the rest of the group knew they were in for a few laughs. Some, of course, were indignant. One disgruntled participant announced that he resented being taken advantage of in his ignorance as a freshman — but that he enjoyed the quiz.

The second year (175 newcomers this time) "we got rid of the nasty comments and gave a more general quiz," explains Yale Sussman, '74, another originator of the F.R.C. "We asked questions most people could — or soon would — appreciate."

By the third year, the freshmen quiz was established. The date was printed in the R/O week calendar; the place was a respectable 26-100; more innocents arrived than ever before: 275. And this time, instead of the previous policy of kicking out upperclassmen who crashed, "we planted our own upperclassmen, complete with a copy of *Gravitation and Cosmology* (a very graduate-student-type physics text for people in theoretical physics) to impress people," explains Mr. Sussman. "We had everything he was to say and do planned. Two-thirds of the way through the exam we caught him cheating and staged a loud argument. We gave him his GN (gnurd) and kicked him out. His tearing up of the exam was accompanied by an anguished 'I guess I'm not going to medical school.' "

Why the freshmen quiz?

"It adds character to R/O week; it typifies the M.I.T. spirit," says Mr. Sussman. "It is technologically oriented. And although considered less than half serious, it is educational too. By matching departments with buildings and numbers, for instance, a freshman learns about the Institute — or what he must know in order to survive here." "Hopefully everyone has fun at no one's expense," adds Ms. Deutsch. "And it gives freshmen insight into what life is like here."

Now, freshmen are not just the victims. "They come into the room with the intention of hacking us back," says Ms. Deutsch. "If they take this with a humourous view, they may realize other things should be taken lightly — or they'll have a tough four years." — *M.L.*

No Posters in Russia

Images of an Era: the American Poster 1945-1975 was among 15 books sent to Russia by the M.I.T. Press last summer for exhibit at Moscow's first International Book Fair. But *Images* never made it into the U.S.S.R. Soviet customs officials found it "anti-Soviet."

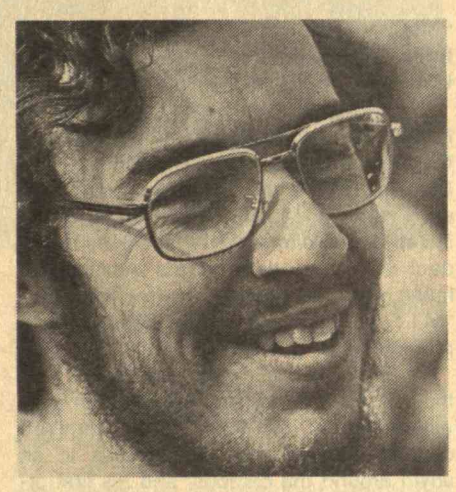
Hard to imagine a collection of American posters having such a strong political message? Frank Urbanowski, Director of the M.I.T. Press, thinks he understands: "The book presents an unambiguous message about the U.S. as a free and vigorous society," he says — "too graphic, apparently, for the Soviet censors."

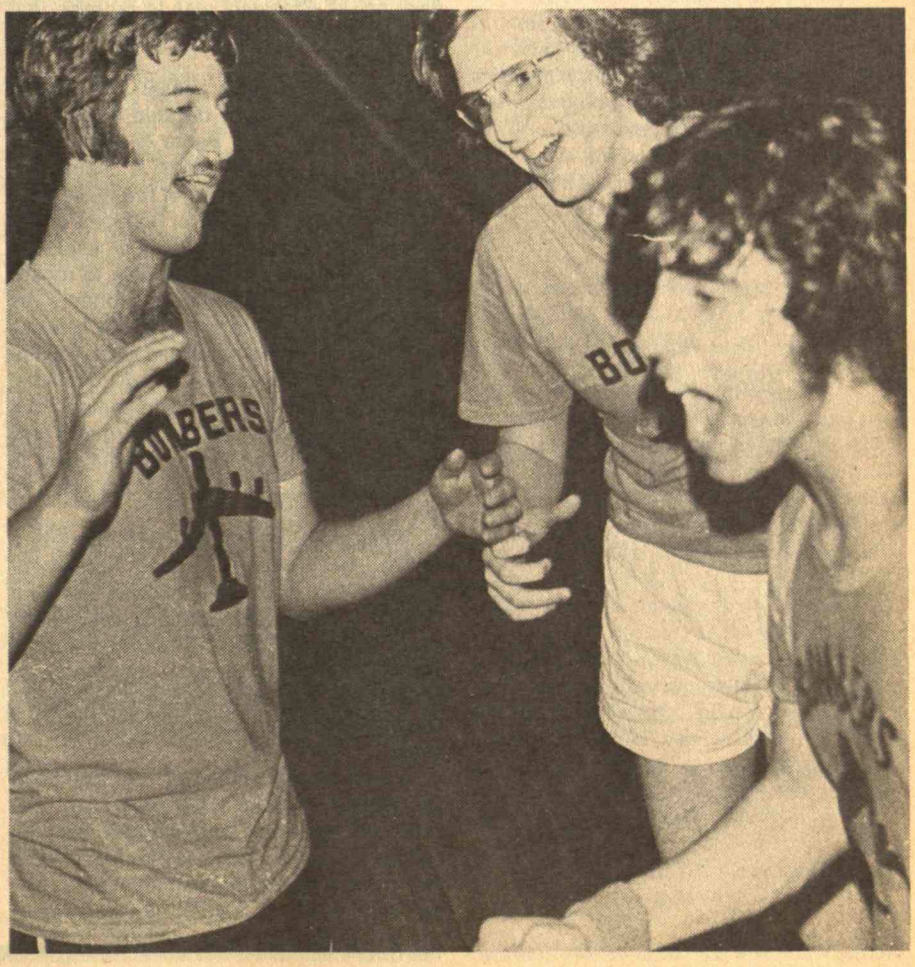
From M.I.T. to Medical School

Just over 140 members of the Class of 1977 and other recent M.I.T. classes applied to medical, dental, and veterinary schools last spring for admission this fall; 99 were admitted, and 96 are now enrolled. The 140 applicants were the source of 2,392 applications, and over 60 per cent of the successful applicants had to choose between two or more schools.

Most of the applicants had undergraduate degrees in the life sciences, but 25 per cent were graduates of departments in the School of Engineering, mostly electrical and chemical engineering.


Carnation





Gordon R. Haff, '79 (in top right photo, caught as he photographs by Bill Hoffmann, '80, courtesy Technique) *spent last year looking at M.I.T. through his camera. Here are some of his observations.*

A spirited defense of the Institute from William Lasser, '78, Editor of The Tech: *". . . School pride does not come in the form of football victories or homecoming dances. Instead, M.I.T. students develop a satisfaction in their very survival: life is no breeze here, but if you can make it you can be proud of it. . . ."*

"Not Harvard, Not Inhuman, Not Intimidating; Just the Greatest Technical University in the World"

How much of Peter Berke's tongue was in his cheek when he told new members of the Class of 1981 at the opening of orientation early in the fall that M.I.T. is a "hard, bleak, isolating environment"? What did the President of the Undergraduate Association mean when he warned the freshmen that "M.I.T. will teach you to solve other people's problems and ignore your own"?

Mr. Berke is a bit of an enigma. He won the U.A. Presidency last spring as an anti-establishment candidate who promised dancing classes and more places to sit down around the campus; and his first official act as President was to promise that the leaves would be on the trees by sometime in April.

But this fall William Lasser, '78, Editor-in-Chief of *The Tech*, decided to take the U.A.P. to task. "Mr. Berke is wrong," he wrote at the beginning of a thoughtful, graceful editorial defense of the Institute:

"The Insider's Guide to Colleges is extraordinarily correct in writing that 'In an age when it has become fashionable to regard technology *per se* and its pioneers as cold-blooded monsters, there is a growing emphasis on the personal and human at the Institute which extends from environmental protection studies to letting freshmen have a lot to say about what they learn and how they learn it.' It concludes: 'If your bent is technology, M.I.T. is definitely the place to go.'

"What more can we ask for? There is a well known tendency among undergraduates to put down the Institute, wearing 'IHTFP' T-shirts and muttering obscenities about 5.41 and 8.012. Upperclassmen tell visiting high school students that they hate the Institute, but, as in the popular Listerine commercial, they keep coming back for more.

"A near-record number of freshmen have just arrived — about 1,100 people who decided that, based on what they see from the outside looking in, M.I.T. is the place where they want to spend the next four years. And last June 6, M.I.T. handed out degrees to some 691 people who decided to stick around and finish.

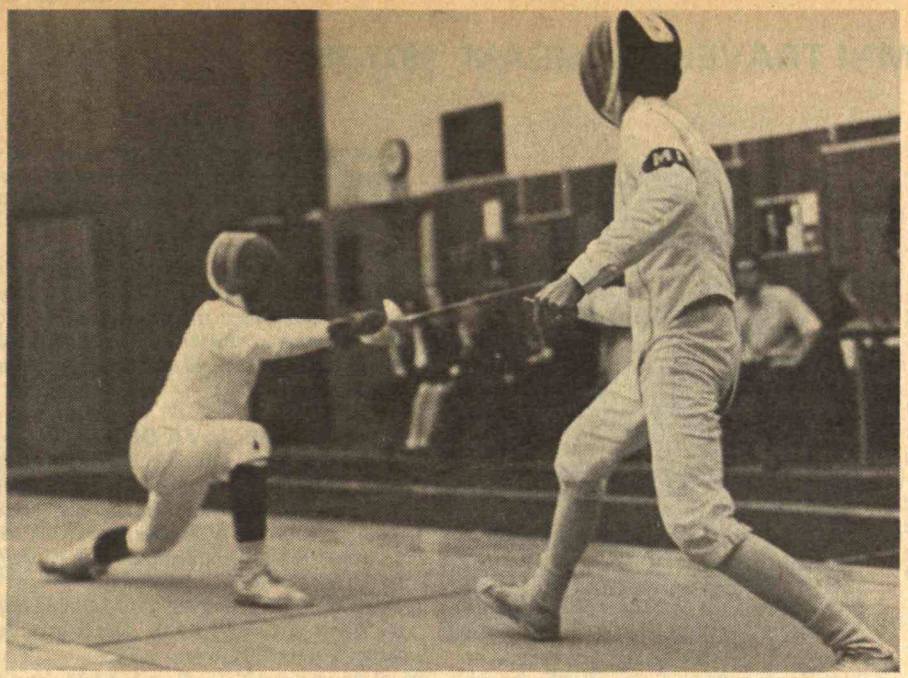
"For M.I.T. students, school pride does not come in the form of football victories or homecoming dances. Instead, M.I.T. students develop a satisfaction in their very survival: life is no breeze here, but if you can make it, you can be proud of it. Being screwed by the Institute and living to tell about it makes one feel even better. Perhaps M.I.T. should award medals instead of degrees.

"It has gotten to the point where one feels uncomfortable saying, 'I like it here.' My guess is that most people do like it. Prospective freshmen visit in April and hear universally negative comments. Some turn around and head for Harvard or Princeton. But many shake their heads, seeing through the disguise. 'It can't be that bad,' they think, and a few months later they find out it isn't; but they dare not say so.

"Berke suggested that there is something wrong with this place because people walk down the halls thinking, 'I'm so involved I can't even see you.' He should go someplace where people have nothing to do. He told the freshmen that they would learn to stand up at M.I.T. because 'there's no place to sit when it gets cold out.' He should go to school in southern Florida.

"M.I.T. people are busy, but they do care. . . . We have to face reality: there *is* a lot wrong with M.I.T. But the problems of an institution like ours are not unique, and they do not exist as a result of some conspiratorial design. Most important, they are not unsolvable. We have difficult questions to face: the future of the humanities program, the severe overcrowding in the dormitory system, and the increasingly unsatisfactory financial situation are but three. But we must confront them in a spirit of optimism and dedication, not complacency and despair.

"We must accept ourselves for what we are. M.I.T. is the greatest technically-oriented university in the world. It is not Harvard, nor would we want it to be. It is not inhuman, it is not intimidating. The problems it has will not be solved by chairs, warmer weather, discotheques, flowers, essay contests, or more trees. Neither will they be made any better by pessimistic stump speeches."



M.I.T. Excels in Fencing

Kenneth L. Calvert, '79

M.I.T. has always been noted more for the quantity and variety of its athletic teams than for their quality. A championship team of any kind is, sadly, somewhat of a rarity. The usual reasons given are lack of athletic scholarships and academic demands on students. But there are sports in which M.I.T. excels at the regional and even national level.

Fencing is one of these sports. Last year, M.I.T. won the New England Championship and placed sixth in the N.C.A.A. National, defeating several of the nation's top fencing powers in the process. M.I.T. is *the* team to beat in New England and actually has been for several years (the Engineers have been N.E. Champions seven years in a row).

Under the able auspices of Head Coach Eric Sollee, M.I.T. is continuing a long winning tradition. Among past greats who have fenced for the Engineers are Joseph L. Levis, '26, who was National Champion several times and took second in the 1932 Olympics, and Johann Adermann (he left M.I.T. in 1971) who was world champion last year. According to Sollee, the great majority of his fencers are not of this superior caliber when they come to M.I.T. "They are generally experienced, but not at a very high level. As in any sport, it is practice that pays off. And M.I.T. students are just as competitive as those anywhere else."

Sollee's own credentials are impressive: All American at Harvard, New England foil champion, and champion of the Far East in all three weapons (foil, epee, and sabre). He is now in his second year as head coach, and has coached part time and taught physical education at M.I.T. since 1971. He is also involved with teaching fencing to the blind.

The team's prospects for this year are good. Outstanding among the returnees is Mark Smith, '78, a sure candidate for All American. Smith, fencing in the epee event, was one-third of the sixth best team in the country last year, along with Arly Sterling, '77, in foil and Richard Reimer '77, in sabre. According to Sollee, if Smith had competed in the foil, his specialty, he probably would have garnered All American honors last year. (Only the top six finishers in each event are named to be All Americans.)

About 40 to 50 students are expected to try out for fencing this year, too many to receive individual instruction from one person. Coach Sollee is assisted by John Chang, captain and MVP of the '73 squad, as well as by a number of interested alumni who "come by, work out, give a few pointers, and help out where they can." Sollee sees fencing as a mental, even more than physical, sport. "It's a skill sport, because you're using a tool. Strength, speed, and size have very little to do with whether you will be a winner. You must analyze your opponent and direct your attack accordingly." Apparently M.I.T. fencers have what it takes, because they seem to have developed that most coveted of sports traditions, a dynasty.

Ken Calvert is a junior majoring in computer science from Kansas City, Mo. He's a member of the water polo and swimming teams.

Fraternity News: Two New Houses and a Highly Successful Rush

Jim Bidigare, '78, I.F.C. Community Relations Chairman

Alpha Delta Phi and the Women's Independent Living Group, the two newest houses on M.I.T.'s campus, are becoming well-established as smooth-running organizations. Both houses had great rush weeks, pledging 37 freshmen between them, which doubled the size of the core groups from last year.

The success of ADP and WILG was contagious as the fraternity system overall pledged 396 of 404 sought-after frosh.

As houses in Back Bay Boston get older, physical plants go through the rigors of undergraduate life and, no doubt, show it. A new awareness is developing among house members and house corporation officers with regard to long-term planning. Houses are now looking hard at renovation or moves to provide safer and more modern facilities for their members.

Sigma Chi spent $110,000 this summer to replace heating and plumbing systems. Among other improvements were new windows in the back of the house and a safety sprinkler system.

A program is being established to provide sprinkler systems for all houses who need them. The Independent Residence Development Fund provided money (in an experimental program coordinated by the Alumni Interfraternity Conference) for the sprinkler system at Sigma Chi, as well as at Theta Chi this year.

These partially concealed systems have worked out well: besides being safe, they fulfill the Boston Building Code, allowing open stairwells to remain.

On November 29, a meeting sponsored by the Interfraternity Conference and the Alumni Interfraternity Conference was held with alumni corporation presidents and treasurers. The discussion centered on matters of long-term planning, information exchange and cooperative efforts.

The fraternity system is sponsoring a new campus newspaper, called *The Beaver*. This paper will include articles on all aspects of extracurricular life and will report news, activities and social events of interest to undergraduates. The first issue was produced November 2.

In an effort to establish more communication between houses, as well as to inform freshmen about opportunities at M.I.T., the fraternity system sponsored a freshman symposium this fall. The symposium drew on administrators and student leaders to give seminars on various aspects of student government, M.I.T. administration, and athletics, to name a few.

Jim Bidigare is a senior in architecture from a suburb of Detroit, Mich.

ALUMNI TRAVEL PROGRAM 1977-78

This special travel program, to some of the most interesting areas in the world, has been especially designed for alumni of Harvard, Yale, Princeton, M.I.T., Cornell, Dartmouth, Univ. of Pennsylvania and certain other distinguished universities and for members of their families. It is consciously planned for persons who normally prefer to travel independently, and covers lands and regions where such persons will find it advantageous to travel with a group.

The itineraries are designed for the intelligent traveler, and offer an in- depth view of historic places, ancient civilizations, archeological sites and artistic treasures, as well as interesting and far-flung cultures of the present day and spectacular scenery from virtually the four corners of the globe. The programs are, however, also planned to incorporate generous amounts of leisure time and to avoid unnecessary regimentation so as to preserve as much as possible the freedom of individual travel, while utilizing the savings and the practical convenience which group travel can offer.

Considerable savings have been obtained by using special reduced fares offered by the world's leading scheduled airlines, fares which are generally available only to groups or in conjunction with a qualified tour and which offer savings of as much as $500 and more over normal air fares. In addition, special group rates have been obtained from hotels and sightseeing companies. By combining these savings with a careful selection of the finest available hotels and facilities, it is possible to offer travel arrangements of the highest standard at moderate and economical cost.

AEGEAN ADVENTURE — 23 Days: The archeological treasures of classical antiquity in Greece and Asia Minor and the islands of the Aegean, with visits to Constantinople (Istanbul), Troy, Pergamum, Smyrna (Izmir), Sardis, Ephesus, Epidauros, Mycenae, Olympia, Delphi and Athens, as well as a cruise through the Aegean to the islands of Crete, Santorini, Mykonos, Rhodes and Patmos. Departures April through October.

MEDITERRANEAN ODYSSEY — 22 Days: An adventure into realms of antiquity in the western Mediterranean, with the ruins of Carthage and the Roman cities of Africa in what is now Tunisia, the splendid Greek temples of Sicily (including the famed "Valley of the Temples" at Agrigento and the ruins of Syracuse, the city of Archimedes), the remarkable Norman churches of Palermo, dating from the age of William the Conqueror, and the fortress cities of the Crusader Knights of St. John on the island of Malta. Departures March through October.

VALLEY OF THE NILE — 17 Days: A detailed view of one of the greatest civilizations the world has ever known, the civilization of ancient Egypt along the valley of the Nile. The itinerary includes Cairo, the pyramids of Giza, Sakkara, Dashur and Meidum, Memphis, Abydos, Dendera, the great temples and monuments of Luxor, including the Valley of the Kings and the tomb of Tutankhamun, and a cruise on the Nile of Upper Egypt to visit Esna, Edfu, Kom Ombo and Aswan, as well as the great monumental temples of Abu Simbel near the border of the Sudan. Departures January through December.

THE ORIENT — 29 Days: A magnificent survey of the Orient, including the exotic temples and palaces of Bangkok and the ruins of ancient Ayudhya, the great metropolis of Singapore, the enchanted island of Bali with its unique artistic heritage, the famed port of Hong Kong on the border of Red China, and a comprehensive visit to Japan which places special emphasis on the cultural treasures and the tranquil beauty of classical Japan at the historic city of Kyoto and at Nara, Uji, Kamakura and Nikko, as well as the mountain scenery of the Fuji-Hakone National Park and the modern capital at Tokyo. Optional visits are available to the ancient temples of central Java and the art treasures of the National Palace Museum in Taiwan. Departures March through November.

BEYOND THE JAVA SEA — 32 Days: A remarkable journey through the tropics of the Far East, from the port of Manila in the Philippines to the tea plantations and ancient civilizations of Ceylon, the Malay Peninsula, the Batak tribes of Sumatra, the ancient temple ruins of Java, the fabled island of Bali, headhunter villages in the jungle of Borneo, and the unforgettable beauty of the lights of Hong Kong. Departures January through November.

MOGHUL ADVENTURE — 30 Days: The great historic and cultural heritage of India, combined with the splendor of ancient Persia and a journey into the high Himalayas in the remote mountain kingdom of Nepal: imposing Moghul forts, ancient temples, lavish palaces, the teeming banks of the Ganges, snow-capped mountains, picturesque cities and villages, and the Taj Mahal, culminating with the famous mosques of Isfahan and the 5th century B.C. palace of Darius and Xerxes at Persepolis. Departures January through November.

SOUTH AMERICA — 28 Days: An unusually comprehensive journey through the vast continent of South America, from the Inca ruins and colonial heritage of the western coast, amid the towering snow-capped Andes, to the great Iguassu Falls and the South Atlantic beaches of Brazil. The itinerary includes the colonial cities of Bogota, Quito and Lima, the great Inca centers of Cuzco and Machu Picchu, La Paz and Lake Titicaca, the magnificent Argentine Lake District at Bariloche, Buenos Aires, the Iguassu Falls, Sao Paulo, Brasilia and Rio de Janeiro. Departures January through November.

THE SOUTH PACIFIC — 28 Days: An exceptional tour of Australia and New Zealand, with Maori villages, boiling geysers, fiords and snow-capped mountains, ski plane flights, jet boat rides, sheep ranches, penguins, the real Australian "Outback," historic convict settlements, and the Great Barrier Reef. Visiting Auckland, the "Glowworm Grotto" at Waitomo, Rotorua, the Southern Alps at Mt. Cook, Queenstown, Te Anau, Milford Sound and Christchurch in New Zealand, and Canberra, Tasmania, Melbourne, Alice Springs, Cairns and Sydney in Australia. Optional extensions available to Fiji and Tahiti. Departures January through November.

EAST AFRICA — 21 Days: A distinctive game-viewing and photographic safari to the wilds of Africa, covering some of the greatest wildlife areas in the world. From the semi-desert of Kenya's Northern Frontier region and the vast game-filled plains of the south to the lakes of the Great Rift Valley and the snow- capped peak of Kilimanjaro, the itinerary includes Nairobi, the Nairobi National Park, Treetops, Meru National Park, Samburu Game Reserve, the Mt. Kenya Safari Club, Lake Nakuru National Park, Lake Naivasha, an extended stay in the great Masai-Mara Reserve, Amboseli National Park and Tsavo National Park, with optional visits to the coast at Mombasa and Lamu. Departures January through December.

Prices range from $1,995 to $3,406 from U.S. points of departure. Fully descriptive brochures are available on each tour, setting forth the itinerary in detail with departure dates, relevant costs, hotels used, and other information. For full details contact:

ALUMNI FLIGHTS ABROAD

White Plains Plaza, One North Broadway, White Plains, N.Y. 10601

02

Arthur L. Collier of Marblehead, Mass., died April 12, 1977 at the age of 97. After graduating from M.I.T. with a degree in mechanical engineering, Mr. Collier worked for 43 years for the old United Shoe Machinery Corp. before retiring in 1946. He was a member of the Marblehead Arts Association, the Peabody Museum and Essex Institute of Salem, and the Steamship Historical Society of America. Mr. Collier is survived by his wife, Dorothy, four nephews and a niece. — *S.F.*

05

To the M.I.T. Class of 1905 survivors: **Roy H. Allen**, Colonel **Robert S. Beard**, **Silas P. Cumming**, **Roger P. Ingalls**, **Gilman B. Joslin**, **Harry C. Kendall**, **George W. Prentiss II**, **Hallet R. Robbins**, **William Spalding**, and **Ralph Whitcomb**.

Hello! and how are you from **Gilbert S. Tower**. Presumably you receive the *Review* as regularly as I do. Probably you are saddened that there is no word from any of your classmates. We miss our secretaries **Fred Goldthwaite** and **Bill Ball**. Perhaps we can keep this column alive.

I can report good health at the age of 92 although I am partially blind and my legs do not work well. However I get around and keep my mind busy by writing editorials for the local papers about town affairs. I will try to keep the 1905 flag waving as long as possible. — **Gilbert S. Tower**, Acting Secretary, 35 N. Main St., Cohasset, Mass. 02025

07

I have no news to report other than the deaths of three classmates this month. Please take a moment and send your news to the *Review* office.

James B. Packard of Leominster, Mass., died March 21, 1977. He was Supervisor of Farming for the Massachusetts State Schools for many years prior to retirement and later was a landscape architect for Weston Nurseries.

Paul L. Cummings of Boston, Mass., died June 20, 1977. He was a graduate of the department of architecture and was construction consultant for the John Hancock Life Insurance Co. in 1945. On completion of the Hancock Building, he stayed with the firm to supervise the renovation of the company's general agencies throughout the country.

Phelps N. Swett of Middlebury, Vt., died July 7, 1977. After receiving his degree in civil engineering from M.I.T., he went to Middlebury College to teach mathematics. Subsequently he became head of their mechanical drawing and surveying department, and introduced and taught economic geography.

In addition, he was a surveyor for the state from 1909 to 1925 and was a trustee and water commissioner for the Village of Middlebury. Professor Swett held positions as director, vice president and president of the National Bank of Middlebury; he helped found the Middlebury Cooperative Savings and Loan Association, and was a director of the Farmers Cooperative, Fire Cooperative Insurance Association of Vermont. — *S.F.*

09

We recently received the following letter from Mrs. Violet G. Proctor, '17: "I noted in the recent edition of the *Technology Review* that the earliest class notes listed for alumni covered the Class of '10. I thought you might be interested in knowing that **Melville K. Weill** of '09, now 90, is still living in his home at 6 Eastview Place, Port Jervis, N.Y. He gets out and around very well, goes to Florida for the winters, visiting his son and family, and on to California to see his daughter, plays bridge a couple times a week. When I drove up to see him last month, we went out to lunch together. The local paper had interviewed him on his 90th as he was a well-known local businessman having started the Skydine Co. there years ago. He was a Phi Sigma Kappa fraternity brother of my late husband, Class 1917 Secretary. I receive the *Review* regularly and enjoy the class notes, editorials, etc. very much." We thanked Mrs. Proctor for her interest in sending this information concerning Melville and have written to him requesting that he send us further news about himself.

We feel highly complimented that the Alumni Association has appointed your secretary a member of the Alumni Council "in view of his currently active role in the Alumni Association." The Alumni Council is the oldest constitutional body in the Alumni Association. Its purpose is to provide a link of communication between the alumni and the Institute. The Council has six monthly meetings during the academic year.

We have received notice of the death of **Edward J. Colgan**, 91, Professor Emeritus of Colby College, on March 27, at Ware, Mass. He prepared for the Institute at the Milton, Mass., High School and at the Institute took General Science in Course IX. After graduating from M.I.T. he continued his education at Harvard University, Universite de Lyon (France), and the Universite de Paris. His entire career was devoted to teaching which he began as a teacher and principal at a consolidated school in Arkansas. In 1922 he became a member of the faculty at Alfred University, N.Y., and two years later he went to Colby College, Waterville, Maine, where he was chairman of the Department of Education and Psychology for 31 years. After retiring from Colby, Professor Colgan continued to teach at Portland University, Maine, and at the University of Maine which conferred on him in 1958 the degree of Doctor of Science. In 1961 Colby conferred on him an honorary degree, the citation reading, "You have embodied in your long and still active career the highest traditions of the noble profession of teaching." During World War I he served as a sergeant in the U.S. Army. Professor Colgan leaves a daughter-in-law, Mrs. Mary M. Baxter of Ware, four grandchildren, a niece, and a nephew.

Just as these notes were about to be mailed to the Alumni Office, we received the sad news of the death of our president, **Arthur L. Shaw**, age 90, on Thursday, October 20. The complete obituary will be presented in the next *Review*. — **Chester L. Dawes**, Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138

11

L. G. Fitzherbert of Wellesley, Mass., writes: "President **Zeke Williams** suggested that each of us survivors take a minute to write a note for the *Review* but no one seems to have that minute. However, I will say that I am still on my feet, doing nothing important, enjoying retirement and pleased that I am alive. Perhaps other classmates can take a minute to tell us what they are doing. I hope to see news of others." Sadly, the *Review* has recently received a letter from Marian Balterton, secretary to **Howard Williams**, informing us of his death September 28 after a brief illness.

From Ft. Myers Beach, Fla., **Harry R. Tisdale** says, "Still enjoy life here on the beach. Many old friends still here after more than 20 years." We have a longer letter from **Sara** (Mrs. Orville B.) **Denison**: "I was so sorry to read of the deaths of the 1911ers in the May issue of the *Review* and realize how few of the old gang are left. But it was good that there were some classnotes to read.

"I feel very sad in having to report Ina MacPherson's death on March 18, a year after Roy's.

"I did hear from **Harry Tisdale** at Christmas time. He still lives in Ft. Myers, Fla. I also usually get a holiday card from **George Kenney** who lives in that same general area.

"My granddaughter, Daryl Denison, is to be married in August to William Popp who was a June graduate of M.I.T. This would have pleased Dennie so much! I now have eight grandchildren and eight great-grandchildren.

"I enjoy living at 'Wellsweep' in Cornish, Maine, during the summer and in Sutton, Mass., during the winter months. My very best wishes to all of you Eleveners."

Two other prominent members of the class have died: **A. Sidney DeW. Herreshoff** of Bristol, R. I., on May 7, 1977; and General **George Churchill Kenney** of Bay Harbor Islands, Fla., on August 10, 1977.

Mr. Herreshoff was chief naval architect of the Herreshoff Manufacturing Co. for many years, the firm which built seven America's Cup defenders, five of which were designed by his father, Nathanael Herreshoff.

After the closing of the company in 1946, Mr. Herreshoff was a self-employed naval architect until his death. A 43-foot yacht of his design recently completed an around-the-world cruise, and two of his designs are now under construction in Bristol. He was president of the Herreshoff Marine Museum, an honorary life member of the Bristol Yacht Club and a member of the Providence Engineering Society and the Bristol Historical and Preservation Society.

1912 classmates and their wives gather at their 65th Reunion this past summer. Members of the Alumni Association staff are invited to join in the picture above.

He leaves his wife, Rebecca; and two sons, Halsey C. Herreshoff, also a naval architect and the navigator of *Courageous* in the 1974 America's Cup races; and Nathanael G. Herreshoff III of Mt. Holly, N.J.

General Kenney served as General Douglas MacArthur's Air Commander in the Pacific during World War II and was called "one of the world's outstanding air leaders" by General MacArthur when he awarded him the Distinguished Service Medal in 1944. When General Kenney retired from active duty in 1951, after 34 years of service, he was awarded a second Oak Leaf cluster in addition to his numerous other medals awarded for bravery in action.

During his flying career, which began as an aviation cadet at the start of World War I, he conceived the idea of mounting machine guns on airplane wings. He also introduced the use of fragmentation bombs on parachutes as well as low-level bombing. From 1946 to 1948 he headed the Strategic Air Command, the long-range bombing force entrusted with the mission of carrying the atom bomb.

He is survived by his wife, Jeanette, and a son. — *S.F.*

12

Jonathan Noyes reports "a great summer on the rock-bound coast of Maine." . . . A card from **Wallace Murray** indicates that he took a short trip to Yellowstone in August but spent most of the summer in Maine. . . . **Harold Brackett** has been quite ill but is slowly recovering. Harold is a strenuous gardener during the summer and insists on fishing on the side. These activities finally got him down and he has had to take it easy while the ground hogs, raccoons and rabbits demolished his garden.

Your secretary and his wife Julie spent the summer as usual at Squam Lake, N.H. After leaving camp we spent a couple of days with Harold Brackett and his niece at their ancestral home in Limerick, Maine, where we enjoyed some of Eleanor's wonderful cooking. We also stopped in to say hello to **Rock Comstock** at Milford, N. H. Rock is doing OK. We found him working on his 150-year-old home. He has been doing this for 22 years and it looks as though it would take him another 22 years to complete the job.

Greetings and Best Wishes for a Joyful Holiday Season. — **Larry Cummings**, Secretary, R.R. 4, Connersville, Ind. 47331

13

We were terribly saddened to learn that our friend, Azel Mack, Secretary of the Class of 1915, has been seriously ill for several months. We are pleased that he is improving. We sincerely hope he is recovering and will be back in his normal good health soon.

So, after three months without any Class of 1913 notes, here we are again. Sorry we missed the Alumni Luncheon on June 10, 1977 — however, three of our regulars reported to us.

Charlotte Sage writes: "We missed you — it was a cold, windy, wet day, but miraculously **Walter Muther** and daughter came down from Westhampton — **Frank Achard** and **Glancy** and C.V.S. made four guys. We sat at a front table with three other alumni (1914,I think) and a couple of younger girls. My friend, Grace Farwell (1929) brought me over or I'd not have tried. Everyone cheery in spite of weather.

"We *did not* appoint a Chariman for our 65th or make any plans, except to agree hopefully that we would meet next year. The talks in Kresge were interesting and gave the old minds something to think about. I did not stay for the reception.

"Hope you have a good summer and thaw out of any troubles. Affectionately, Charlotte Sage."

Warren Glancy writes: "Perhaps you know already that there were four of us at Cambridge on Technology Day, plus two guests. The luncheon was similar to other affairs of recent years with interesting remarks by members of the 25-, 40-, and 50-year classes as the contributions to the Alumni Fund were announced.

"As 'Seniors' we were in the front row — three tables were reserved for the Classes of '03 to '16 inclusive. The only one present from Class of '14 sat at our table. There was less than a tableful of 1913 which was the first class to be recognized as a five-year reunion group. We hope that you and your efficient, helpful and charming assistant secretary will enjoy the crisp Maine atmosphere for a long time. Sincerely, Warren E. Glancy."

Frank Achard phoned announcing the death of **Dave Nason** and also stated that we should have a 65th Reunion. We do not fully agree as we believe there are very few classmates who are able or interested in attending a two or three day reunion. However, our president, **Henry Glidden**, has appointed **Frank Achard** as Reunion Chairman. We will, of course, cooperate with him and give him all the help and information we can. We expect you will hear from him shortly. There have been several deaths during this year, including two widows. Notes of sympathy were sent to the families: Mrs. **Clinton E. Pearce**, 19811 Greenwood Pl., Seattle, Wash., died April 27, 1976; Mrs. **Geoffrey M. Rollason**, 935 Belvidere Ave., Plainfield, N.J., died March 30, 1977; Dr. **John A. Gann**, 630 S.W. 6th St., Pompano Beach, Fla., died September 14, 1976; **Paul E. Rudolph**, 77 W. Washington St., Chicago, Ill., died February 2, 1977; and **David V. Nason**, 7031 No. Belmont Lane, Milwaukee, Wisc., died April 19, 1977.

The *Milwaukee Journal* reported that Dave Nason died of a heart ailment. He had been president of the J. Laskin and Sons tannery during the 1950s having joined the firm in 1930. He retired in 1956. A native of Salem, Mass., Dave graduated from Exeter Prep School and M.I.T. Before going to Milwaukee, he was employed by the Halburn Thompson Co. of Salem. Dave was a member of the Milwaukee Club. Survivors include his wife, Ruth; two daughters, and two sisters.

Rosalind and I had a nice note from Mrs. Ruth Nason, which included the above-mentioned newspaper article about Dave's death. She wrote: "Thank you for the kind letter — we had gone to Barbados on January 1 as we have been doing every winter since Dave retired (or semi-retired) and had 25 years of great fun and adventures, investigating life on the Caribbean Islands, but spent most of our winters on beautiful Barbados. We had been back in Fox Point a very short time when his heart gave out.

Tom Lough writes: "I was saddened upon learning of the death of my old friend, **Jack Tullar**. He was also a fraternity brother of mine. It has gotten so I hesitate to view the obituary column in *Technology Review* fearing that another friend's name will appear from the dwindling members of our class.

"I wish to report the arrival this month of our first great-grandchild. Genevieve and I are both too lame and decrepit to attend any future gatherings of the 1913 Clan. We have fond memories of the 50th Reunion at Oyster Harbors. That was the apex. I suspect that I am the oldest living member of our class. I shall be 88 years old on June 20. If I have a competitor let him raise his right hand if he has the strength to do so. Every good wish to you and Rosalind."

That is all for now. — **George P. Capen**, Secretary and Treasurer, **Rosalind R. Capen**, Assistant Secretary, Granite Point Rd., Biddeford, Maine 04005

14

While **Alden Waitt** was visiting his daughter Betty (Mrs. John W. White) at Fort Gordon, Ga., last summer, she made him a cowhide "Beaver" belt — an idea for other good daughters.

Lyman S. Baird, whose death on November 6, 1976, at the age of 86 was mentioned briefly in these notes in the last issue, was born in Austin, Minn., entered the Institute from the University of Minnesota at the beginning of our junior year, and graduated with us in Course II. During the first ten years after that he held engineering positions in Cleveland and Detroit with several corporations, including Ferro Machine and Foundry, Firestone Tire and Rubber, Sunnyhome Electric, and General Motors. He served in World War I, and in World War II he was attached to the 33rd Brigade in charge of the defense of San Diego. In 1924 he joined the staff of the Dampier-Baird Mortuary in St. Paul, Minn., and was its owner when he retired in 1954 and moved to San Diego, where he lived until his death. In 1921 Lyman married the former Eunice Pauline Kegg, who survives him, as do their daughter, Mrs. Patricia Connolly, of San Diego, and a grandson.

Charles Leon Cowles died on August 18, 1977, at his home in New City, N.Y., at the age of 86. He was born in Lynn, was with us in all our undergraduate years, and received his bachelor's degree in Course VII. After employment with several companies in Pennsylvania and Chicago for about ten years, he spent 34 years with the Lederle Laboratories in Pearl River, N.Y. Beginning in 1960, he worked for some years in the Pathology Laboratory of Nyack (N.Y.) Hospital. Leon was a member of Nauraushhank Lodge 939 of the Masons. He was married to the former Cora May Parsons in 1915 and is survived by her and two sons, Donald, of Redding, Conn., and Laurence, of Odessa, Fla.; a daughter, Mrs. Leona Thampson of Pearl River; eight grandchildren, and eight great-grandchildren. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, Conn. 06119

15

Hello everybody! I'm back on the job and really glad to be back with you. While I was in the hospital there were many cards, letters and messages from classmates and their families and friends or our class. I want you all to know that I appreciate these very much and thank you for your thoughtfulness. They were helpful and cheerful and did me a load of good.

I'll try to catch up with some of our belated class news. In the 1977 Alumni Fund, 60 per cent of our active class alumni contributed. This was one of the largest percentages by class contribution.

Practically all the local classmates came to see me in the hospital or phoned me — **Larry Landers**, **Bill Brackett**, **Wayne Bradley**, **Alton Cook**, **Dinger Doane**, **Clive Lacy**, and **Wally Pike.** It was good to see and talk with them all.

Jerry Coldwell has had some eye trouble but was able to get up into New England for part of the summer. He ended his splendid letter with "after all, we're not getting any younger." And I think that goes for most of us. **Alton Cook** plans to be up here to see me sometime this fall. He recently has felt the touch of age and has had to slow down. **Dinger Doane** is visiting on the West Coast and is very much impressed with the scenery.

Otto Hilbert has joined a group of M.I.T. men working at Corning Glass Works where he formerly was in business, for social meetings. Most of them are younger graduates and were surprised to hear his description of "Boston Tech" and the story of "Mr. Smith."

Mary Plummer Rice continues to travel; after her famous Russian trip last year she attended the Conference of the International Federation of University Women in England. She believes that the Massachusetts General Hospital where I was boarding for a time is one of the best in the country. . . . **George Easter** went on one of the M.I.T. Quarter Century Tours to Europe but found that most of the travelers were much younger.

The Belmont, Mass., local newspaper had an excellent picture of **Henry Sheils**' son Bill heading up the alumni drive at Wentworth Institute in Boston. Bill is the son of our own deceased **Henry Sheils** who was so active and interested in our class and M.I.T. Dr. **Jim Tobey** was at the Dartmouth alumni convention in Hanover, N.H., last summer and took the time to visit some of his family in that part of New England. He continues very active with his professional work.

Bob Welles wrote class agent Joyce a long letter in April about his travels back East to visit Henry Lieb's widow and his travels up to see the Tall Ships. Unfortunately he was laid up in a small hospital in southern Massachusetts from which he had to fly home to Altadena, Calif. He recovered sufficiently to go back East to complete his trip, and he was hospitalized again from this jaunt. But I think he has recovered and is staying put at home. In his long and interesting letter to Joyce he wrote about some M.I.T. activities he is in. "We have a small group of M.I.T. men (about 20) who meet once a month in Pasadena for lunch. Colonel Philip Schwartz, M.I.T. '23, and I manage the details. We had the idea in the beginning that the lunches would be more interesting if we could have some general discussion and not just each man chatting with his neighbors. For awhile we took turns bringing up a subject and then all discussing it. Now it seems to have gotten down to the point where Phil and I have to find somebody, usually outside the group, to talk, and it is becoming a lecture course. The attendance has grown, but we never contemplated organizing a series of lectures, and we feel as though we had a bull by the tail. . . . Have you any suggestions?"

Ben Lapp wrote a cheerful letter from Buffalo. He has five grandsons and one great-granddaughter, the families of his daughter Evelyn and son Marshall. He's very proud of the success his family has achieved. Ben and I went to high school together in Boston and worked together on our first job out of Tech in the summer of 1915 at the Canadian Explosives, Ltd. plant at Nobel, Ontario, where we made and loaded three-inch artillery shells for the British Army.

I hope these notes will catch you up for the time I've been laid up. And I hope to be able to resume our regular column very shortly. These are prepared with the kind assistance of a secretary from the *Review* office.

George Simons, Jr., died July 8 after a long illness. He lived in Jacksonville, Fla., where he had been very active in civic affairs, especially in health and sanitary work for the city and the state of Florida.

Max Woythaler of Framingham, Mass., an active and generous member of our class, is in St. Patrick's Manor, Framingham. I saw Max once last spring shortly after he was admitted, but haven't seen him since and I fear he's been having a tough time.

Again I send you all many thanks and I wish you and your families a happy and healthy holiday season with a bright New Year coming up. As a result of my illness I am unable to write well or much so instead of sending Christmas cards this year I'm sending you all the best. — **Azel Mack**, Secretary, 100 Memorial Dr., Apt 26A, Cambridge, Mass. 02139

16

First things first: we welcome this opportunity to wish all of our classmates much happiness and good health throughout the Holiday Season and also in the New Year.

We're pleased to pass on to you parts of a nice letter from **Nat Warshaw**, who missed our reunion on the Cape this year due to an unfortunate "flare-up" of arthritis. Now, he writes, "Am glad to say that I was sufficiently recovered to attend my regimental reunion, the 60th, in Quincy. We were Army Artillery not attached to any Division and also overshadowed by the 26th, so we never received much recognition. The reunion brought to mind the many hours I spent in the city of Angers, France, at the Artillery School under the tutelage of some of our own classmates. I remember we were hustled out of a similar school near Chateau-Thiery just prior to the 'Battle' and shipped to Angers. Those were the days!" A newspaper report of the regimental reunion tells one of Nat's recollections while he was a lieutenant in the 55th: " 'One of our forward elements was badly in need of ammunition and rations,' Warshaw said, 'but I knew that if I tried to send a truck up the one-way road to the front, which was being heavily shelled by the Germans, I'd probably never get the stuff where it was needed. By comparison, the rearward road was not being shelled; so, taking a gamble, I wrote out an order which allowed one of our trucks to go up against the rearward traffic. The order, to which I signed Pershing's name as authority, allowed the driver to get by the military police checkpoints and deliver the needed supplies and munitions to the outfit.' It was literally a forgery of the name of General John J. 'Black Jack' Pershing, Commander-in-Chief of the A.E.F. But, said Warshaw, 'I felt it was a necessary order and in line with the overall directives for the Argonne battle; and, so as insurance, I added my own name and rank under Pershing's in the event the order was questioned.' Mr. Warshaw, still a powerful, erect figure despite the passage of years since he wore the uniform of 1918, laughed when he said, 'I would probably have been courtmartialled if the thing hadn't gone off right, but I guess by now the statute of limitations has run out.' "

From **Francis Stern**: "I had hoped to go up to the Institute for the Alumni Officers' Conference which I attended a few years ago and found most interesting. However, since my trip at the time of the reunion to the Retina Institute in Boston, the clamps holding my implanted lens have become displaced. I had one hospital siege June 21 but since then one or more of the supporting clamps have become dislodged. We hope that my coming operation on Thursday next will be definitive for I can barely read even with a magnifying glass." I talked with Francis shortly after his operation and he acknowledged a little improvement and the hope of more once the medicine has taken its full effect. He and Gladys were then making plans for their annual trip to Palm Springs.

Dick Fellows recently wrote: "Thank you for the picture of the 61st Reunion. Both Edith and I wish that we could have been there. Maybe next year. We are both still active. I am on the Board of Governors and also Historian of the University Club of the Desert. We are active in the Palm Desert Community Presbyterian Church — where I am an elder. Even though we are in the midst of many golf courses we don't play much since we don't seem to have time. A few years ago, when I was wearing my red 50th Reunion coat, an M.I.T. man spoke to me in Palm Springs. He asked me where I golfed; and when I said I didn't, he responded, 'Why, what *do* you do?' Well, here's part of the answer: we spent seven weeks last summer in Washington and Oregon, visiting our daughter, three grandchildren and seven great-grandchildren. Our son Rowland is with I.B.M. and lives in Carmel, and his son is also with I.B.M. in Helena, Montana."

Maury Holland writes regularly and in one of his recent letters suggested that we start a "Classmate Letter Club," once a month each member writing a letter to a classmate. He says

that at his age, 86 years, letters from old friends are *the event of the day*. He was busy making arrangements for his winter in Florida. His usual accommodations have been converted to another use, so he was searching for a new location. . . . **Jack Camp**, a resident of Mexico City for many years, wrote that he is well.

We regret to report the passing in August of **Earl Townsend** and **John Stafford**. Earl had been in a Nursing Home in Waltham, Mass., for the last four years; he had retired from Factory Mutual Insurance Co., where he was an appraiser, in 1960. John was a retired mechanical engineer in the sugar industry and was living in Hohokus, N.J., at the time of his death.

We would appreciate hearing from you with any news items for the column. Keep breathing and keep writing. — **Ralph A. Fletcher**, Acting Secretary, P.O. Box 71, West Chelmsford, Mass. 01863

17

Tom Meloy has recently been cited by the American Council for the Arts for his work in making possible the publication of the book *Carter on the Arts*, as follows: "A.C.A. is deeply indebted to Thomas Meloy for making the publication of this book possible. Dr. Meloy is a graduate of Harvard and the Massachusetts Institute of Technology. He is a member of the Board of Trustees and Honorary Producer of the Arena Stage of Washington, D.C. He is also a member of the Council for the Arts at M.I.T. His concern arises from the conviction that 'knowledge of the arts makes better engineers.' " Congratulations to Tom.

It has been suggested that if you happen to be in Cambridge, that you visit the Office of the Chairman and the President of the Institute, and you may be met by Ellen Woodward Reinhard, the granddaughter of Edna and **Brick Dunham**. One can observe her graciousness and competence, which are inherited traits.

Jack Wood regrets his inability to attend our 60th Reunion and was expecially interested in our luncheon for the Presidents' wives at Endicott House. He thought it a great idea. For some years he was House Master of Senior House and "the Comptons were friendly neighbors who went out of their way to look after the welfare of the neighboring students." Later when he and Helen lived in Watertown, they were close friends of the Wiesners and all their children attended the same schools.

Howard Melvin wrote recently to **Stan Dunning** from Santa Rosa, Calif. He called our 60th "a wonderful class reunion." On his way home via New York, he visited his old friends in New Jersey and also his old Ebasco Services office in New York City. He plays golf regularly and feels fine.

We regret to hear that Betty **Hulburd** (**Phil**'s widow) has been hospitalized in Claremont, N.H. The class extends its sympathy to her.

Final reports have been received on the 1977 Alumni Fund. A total of $102,573.60 was contributed with 64 per cent of the class participating, This was a remarkably high participation.

This month we are sorry to report the deaths of five of our classmates. A letter from Gladys Schoonmaker reported the death of her husband, **Lucas E. Schoonmaker**, on June 24, 1977. Colonel Schoonmaker served in the Army Coast Artillery and later in the Anti-Aircraft until he retired in 1947. In 1945 he was knighted by Queen Wilhemina of Holland as Knight Commander of the order of Orange, Nassau, for services performed in command of troops in Dutch Guiana. In 1947 he joined the Faculty of the University of Florida and taught electrical engineering. He retired in 1966 with the title of Professor Emeritus.

James J. Storrow died on July 3, 1977, at his home in Marblehead. He was a graduate of Harvard University, class of 1915, and of M.I.T., class of 1917. He served in the Navy in World War I and later was a trustee and investment banker. Forest conservation was an abiding interest and he spent many years in that field of activity.

Francis Goodale died on August 18, 1977. He resided in Stroudsburg, Penn., and spent many years as a construction engineer. He worked on projects in Hawaii, the Phillipines, and South America. He always attended our five-year reunions and may be remembered by many of us.

Frank E. McKone died June 23, 1977, at his home in Dover, N.H. After graduating from Dartmouth College, he obtained his master's degree in aeronautical engineering at M.I.T. He was associated with the faculty of the University of Washington and worked with Boeing Aircraft in Seattle.

The death of **Roy C. Sylvander** occurred on November 4, 1976. He resided in Ridgewood, N.J., and was employed for many years in aeronautical instrumentation and became Director of Engineering of the Eclipse-Pioneer Division of Bendix Aviation Corp. His son, Frederick, graduated from M.I.T. in the Class of 1947. — **William B. Hunter**, Secretary, 185 Main St., Farmington, Conn. 06032

18

Once again I can report to you on the 1918 mini-reunion at Endicott House, September 24. Because of the inclement weather and sickness, the '18 contingent was small, but we were happy to have our number augmented by friends from the classes of 1917, 1919, and 1920. The program was most enjoyable. In particular, the talk by Professor Alan Altshuler, Dean of the M.I.T. Department of Political Science, proved to be of great interest. He traced the history of this academic discipline which started from the M.I.T. post-war contracts with the U.S. Government. These studies had international involvements and therefore required political analysts. The experts who came to our campus to advise on these problems in a short time were teaching post-graduate students to assist them. The next development expanded the curriculum to undergraduates, and now M.I.T. is recognized as a national leader with its Department of Political Science. All this in about 20 years. The '18ers included **Pete Strang**, Jean and **Julie Avery**, Frances and **Pete Harrall**, Eunice and **Ted Braaten**, Elizabeth and **Julie Howe**, Gladys and **Len Levine**, and Selma and **Max Seltzer**. Kudos to the Harrall's who came here from Baltimore for this event.

At the 1977 M.I.T. Alumni Officer's Conference, our class was represented by Elizabeth and **Julie Howe**, **Eli Berman**, Gladys and **Len Levine**, and Selma and **Max Seltzer**. There were the usual reports and talks by the faculty. The highlight was the dedication of Huntington Hall (Rm. 10-250) with the new purple chairs and wall to wall gray carpet. Two chairs were of interest to '18 — one given by **John Kilduff** and the second in memory of **Tom Kelly**.

I am happy to report to you that after a confinement of several weeks in the hospital and at home, **John Kilduff** is much improved. I expect to see him at the Alumni Council meeting on October 24.

Our mini-reunion brought letters of regret from many of you — too many to acknowledge here. I was particularly moved however, by a telephone call from **Jim Bugbee** from California giving me his warm greeting to express to all of you — and looking forward to being with us in June for our 60th. I was also much pleased with a most gracious note from Buzz Burroughs, '20, who participated in our mini-reunion. — **Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard Levine**, Assistant Secretary, 599 Washington St., Brookline, Mass. 02146

19

James R. Moore writes, "After our third cruise on the *Kungsholm* with three months in the South Pacific, we retired to 10 Oak Circle, Farmington Country Club Estates, Charlottesville, Va. Unable to hire any help to keep the place in order, we sold the estate in Hightstown, N.J., and now we are in the most beautiful and wonderful retirement home and love it. We will be at Hillsboro Club, Pompano Beach, Fla., in the winter."

Donald D. Way and Barbara have toured Europe this summer and from their card were enjoying it immensely.

Your secretary saw **Donald W. Kitchin** and Evelyn at their home, 4 Columbia Ave., Brunswick, Maine, this September for a short visit. Don has taken on a new lease on life and is now reading classic Greek in Greek for some of his past-time. We remember how he used to read novels in about seven languages during his undergraduate days.

Word was received from **Ellsworth G. Paterson**'s son at Cornell University of the death of Ellsworth. He was living in Eastchester, N.Y., and was still active in consulting in the field of communications.

James J. Holt, former professor at M.I.T. in mechanical engineering, retired in Duxbury, Mass., has passed away recently. He was active in local affairs.

Your secretary spent the summer first in Chautauqua, N.Y., then near Portland, Maine, and Washington, D.C., returning to Delray Beach in October. — **E.R. Smoley**, Secretary, 50 East Rd., Apt. 11E, Delray Beach, Fla, 33444

20

In an attempt to round up classmates for the September mini-reunion of Classes '17 through '20 at Estabrook House in Dedham, I received some nice letters from **Bill Dewey**, **Norrie Abbott**, **Dick Gee** and **Buck Clark**. The Deweys, Gees, and Clarks decided Dedham was a bit too far to warrant attendance — luckily so, since the weather for that date was atrocious. However, Beth and **Ed Ryer**, and Pat and **Buzz Burroughs** braved the elements along with Amy and me, and a good time was had by all. Betty and Norrie Abbott happened to be at Skytop in the Poconos, which seemed a very good alternative to us. At the reunion it was disclosed that Beth and Ed celebrated their golden anniversary in August. When I chided Ed for not letting me know, Buzz remarked that possibly it was because he wasn't sure Beth would renew the contract.

Another August golden anniversary was observed by Ruth and **Elbridge Wason** of 9 Edgewater Dr., Wellesley. This gala affair was attended by the Wasons' two daughters and seven grandchildren. . . . Helen and **Al Fraser**, also of Wellesley, celebrated their 50th anniversary too. Their son and daughters and grandchildren were present for the auspicious occasion. Al and Helen are among Wellesley's best known citizens, Al having owned and operated Fraser's Flowers since 1936, and Helen a graduate of Wellesley College, an accomplished pianist, and a teacher of English in the local schools. As one who can scarcely recall his 50th six years ago, I congratulate these "younger" couples.

A very gracious note was received from Lois **Smiddy** of New York City, to say that she and **Harold** appreciated reading notes of the class. Her kind words were appreciated by the secretary who sometimes wonders whether the class news is read by the members.

Sadly, your secretary reports the death of **Bob Tirrell** on August 14 last. Bob and Eleanor resided in Lebanon, N.H. Bob had a distinguished career as a professional engineer specializing in the design of steam electric power plants as well as manufactured gas and chemical plants, oil refineries, and industrial plants. His work took him to New Jersey, New York, and Hamburg, Germany. He was a member of the American Society of Mechanical Engineers, American Gas Associates, and several masonics bodies. Bob was actively interested in geneology, compiling a history of the Tirrell family going back eight generations to a founding ancester who settled in Weymouth, Mass., in 1686. He is survived by his wife, two sons, and three grandchildren. A popular and loyal member of the Class, he will be sorely missed by us all.

Harry Granger died on August 10. A resident of 98 Randolph St., South Weymouth, Mass., Harry served as treasurer of the Town of Weymouth for 19 years until his retirement in 1962. He leaves his wife, Laura.

Franklin H. Blackmer of 928 Middle St., Bath, Maine, died on September 9. After graduation from M.I.T., he was graduated from New Church Theological School in Cambridge. He was a Swedenborgian minister with pastorates in San Francisco, Urbana, Ill., Ohio, Brockton, Mass., Palos Verdes, Calif., and Laporte, Ind. He was President of Urbana College and the New Church Theological School. He moved to Bath upon his retirement in 1968 and was active in various church organizations including the American New Church Sunday School Association. He was a trustee of the Rotch Fund, a member of the Board of the Bath-Brunswick Mental Health Association, and Chariman of the Bath Ministerial Association. He wrote a history of the City of Bath for the Bicentennial and recently published a bibliography of publications by Swedenborgians. He is survived by his wife Eunice, three sons, a daughter, 14 grandchildren and one great-granddaughter. — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, Mass. 01890

21

We are grateful to Barbara Lloyd Hayes, daughter of Emma and **Al Lloyd**, for sending us a clipping from the August 24, 1977, issue of *The Sun*, Westerly, R.I., telling of the presentation of the National Grange Citizens Award for the year to "**Leon A. Lloyd** in recognition of outstanding service to this community and mankind. Your dedication and personal involvement are gratefully and sincerely acknowledged by the members of Westerly Grange." Congratulations, Al! The news column goes on to tell of Al's activities over the years as President of the Lions Club, Secretary to the Merchants Association, Chairman of the Red Cross Fund Drive in 1938, President of the Chamber of Commerce, Director of the Y.M.C.A., and many more. Al was recalled to active duty with the army in 1942 and served as Post Engineer at the Quartermaster Depot in Boston. He retired as Lt. Col., Corps of Engineers in 1946. Barbara reported in her letter that Al had made a good recovery from his heart attack last May.

My good west coast correspondent **Grant Miner** sent me in June a copy of a manuscript on the SaccoVanzetti Case which he had submitted to the *Atlantic Monthly*. He has given me permission to quote from this most interesting manuscript. I'd like to quote it in full but space doesn't permit. Here goes: "Referring to 'The Never-Ending Wrong. . . . Sacco and Vanzetti Fifty Years Later' by Katherine Anne Porter in the *Atlantic Monthly* for July, 1977, I'd like to add my own two bit's worth. In the fall of 1919, I enrolled at M.I.T. after graduating early in the summer from Carleton College. My schedule was a heavy one, as I proposed graduating from M.I.T. in two years instead of the three M.I.T. preferred. One of my professors was Charles B. Breed of the engineering firm of Breed and Barrows in Boston. I'd had to borrow money to finance me at Tech, so I let it be known I was looking for work in my spare (?) time. One of my first jobs was with Professor Breed at South Braintree where a hold-up, robbery and murder took place. On weekends we went to South Braintree to make a 'plane table' survey of the entrance to and environs of the shoe factory. This was the only time I was ever to use this surveying method. Professor Breed went to great lengths to explain to us why it was ideal for his purposes, which was to show in the courtroom the physical layout of the encounter scene with all the obstructions and the distances clearly delineated. Also it required a crew of only three — two of these students.

"Professor Breed was called to testify at the trial and brought his survey map into court. When he was asked if he measured one particular distance he replied, 'No, I estimated it.' This brought up a lengthy controversy about estimating vs. guessing. Breed said that as an engineer he was accustomed to making estimates and definitely did not call them guesses. The attorney started pressing his luck with, 'If, as you say, you're an estimator, please give us your estimate of the length of this courtroom.' After he'd looked the room over, Professor Breed did give his estimate as 88 feet, 6 inches. During the room recess the steel tape was unrolled and the length measured at 89 feet, 2½ inches. In this manner, Professor Breed qualified as an 'Expert Estimator' and his testimony was given added weight by the court and jury. I might add that he never believed in the guilt of the pair on trial.

"Besides the South Braintree job, we worked together in the Boston subway at night, using flashlights and dodging trains as they came barrelling along. Northeastern University asked Professor Breed to recommend someone to teach surveying to freshman students two afternoons a week. I got that job and did my own classwork on the trolley cars going to and from school.

"As a teacher, Professor Breed never needed to take his hat off to anyone. He had that happy faculty of being able to make his students THINK! I vividly remember one day in class in Railroad Engineering he had me up at the blackboard, proving some theorem. In the second step, I made a mistake. He didn't call it to my attention nor did he let the class fault me. He let me go blithely along and hang myself. When I got down to the end and the final proof, I realized my mistake, took the eraser and with one big stroke, cleared the board with the remark, 'Therefore, that's all a bunch of bunk!' The class howled — they had thought I wouldn't catch the error and were waiting for me to hang myself.

"Charles B. Breed was a gentleman, and engineer, an author and a scholar. He was one heck of a fine man and I'm proud to have been able to call him my friend. Marianne and I revisited M.I.T. in 1935 and called on Professor Breed in his office. It was a most satisfying, reuniting experience."

A note from **Whittier Spaulding** dated August 22, 1977 reported his receiving a telephone call at his summer cottage in Maine the day before, with the news of the death of **William Corydon Kohl** of Miami, Fla. Said Whit, "He and I were thesis mates in '21 and then went back to Tech in 1922-23 as lab assistants under D.C. Jackson and Carlton Tucker." Kohl during his business career became New England agent for Century Electric Co. Over the years, the Spauldings and the Kohls saw quite a bit of each other.

Irving Jakobson wrote in late August: "I cruised on *Dowsabel* during July for about ten days — didn't get very far east this time. Went to Newport to watch some of the 12-meter yachts in their trials for the America's Cup defender. We're going to Newport on September 12 to witness the first two races. Last night Ruth and I were hosts at the Yacht Club to Jane and Dayton Brown and had a nice evening together. Dayton is getting along fine with his pacemaker and still keeps reasonably active in business."

Your scribe has five "life histories" on hand which Assistant Secretary **Sam Lunden** received in response to his request. We'll cover two of these this month:

Michael Treshow of Del Mar, Calif., writes "The following is a list of places I have worked from 1922 till 1966: 1922-29, F.L. Smidth and Co., Copenhagen, Denmark, as design and field engineer. The company designs and builds cement making machinery and cement factories. 1929-49, same company in New York City and also for Monolith Portland Cement Co., Los Angeles, Calif., as General Superintendent. 1950-58, Engineer, Argonne National Labs, Reactor Department. 1958-66, Engineer, General Atomic Division of General Dynamics Corp. working primarily on a research project for nuclear propulsion for spacecraft. During my career, 20 to 30 patents were issued in my name. I retired in 1966 due to failing eyesight."

Dick Morris of Santa Monica, Calif., wrote that he had a kidney removed last May, and other health problems the past two years. His wife died in 1974. "The earlier editions of *Who's Who in Engineering* give a good summary of my activities up to the time I retired in 1962. I am a past president of the American Institute of Plant Engineers, and the Society of Business Magazine Editors, and a fellow of the Institution of Plant Engineers of England. I was retired from the Air Force as a Colonel and had active duty in World War I, World War II, and the Korean War.

"On leaving the Institute I was for a short time a junior engineer on the *S.S. Kroonland* running between New York and Antwerp. Soon I had a call from the Worthington Corp. regarding an application I had made for their student engineers course. I took the course and later was assigned to their El Paso office covering a large territory in New Mexico, Arizona, western Texas and northern Mexico. The activity was largely with mining companies. Eventually I went with the United Verde Copper Co. at their Clarkdale smelter to install a large condenser. The smelter smoke caused my wife to have acute asthma and I had to move on.

"I began writing for several engineering magazines and was eventually offered a job with *Power Plant Engineering*. After active duty in World War II, I returned and became first editor of *Plant Engineering*, started at that time. I retired in 1962 after which my wife and I spent three years traveling in the Pacific area. In the course of editorial activities, I traveled over a good part of the world." A post card received from Dick in August told of a further trip with his daughter to Spain, Portugal, Morocco and the Azores, reaching "home about Christmas."

Besides the death covered above, there are two others to report this month: **A. Ilsley Bradley** of Cleveland, Ohio, on March 2, 1977, and **J. Morton Briggs** of South Dartmouth, Mass. On July 27, 1977. Bradley was a graduate of Western Reserve University, but was also associated with our class in 1921. He spent his career in the real estate business and owned his own company. He retired as Senior Land Agent of the Cuyahoga County Engineers' Office in 1970. Briggs worked for the Precision Grinding Wheel Co. of Philadelphia as District Sales Manager. The sympathy of the class is extended to their families.

A postcard was received today from Helga and **Jim Parsons** addressed to Mr. and Mrs. MIT Hayward. Alas, the Parsons are moving from Sarasota to 3450 Gulf Shore Blvd. North, Apt. 407, Naples, Fla. 33940. Betty and I will miss seeing them in Sarasota this month.

Your Secretaries wish you many joys over the holidays and a happy and healthy New Year. — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden,** Assistant Secretary, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

22

We continue the 55th Reunion news begun in the October/November *Review*. On Sunday, June 12, about 20 couples took the lovely drive on wide highways to Whitefield, N.H., beyond the Presidential Range. Anna and **Bunt Spalding** greeted us all and placed us in lovely quarters. The Spalding Inn Club is a convenient and beautiful facility. We played golf on two course and took advantage of the putting green and the lawn bowling facilities (the swimming pool was a little chilly at this early season). We enjoyed guided auto tours of the Franconia Notch area. The meals were the best and we especially enjoyed an evening of "Scenes and Stories of the White Mountains" given in the Sportshouse by the N.H. Division of Parks. Wednesday's departure came all too soon as we took picnic lunches in our cars and drove south through Vermont. The Class picture taken at the Spalding sign showed 42 happy relaxed '22ers willing to visit again.

Abbott L. Johnson, Chairman of the Nominating Committee, presented a list of officers as follows: President, **Parke D. Appel**; Class Estate Secretary and Agent, **Donald F. Carpenter**; Vice President and Representative to Alumni Council, **Marjorie Pierce**; Area Vice Presidents, **C. Yardley Chittick**, **William H. Mueser**, **Elmer E. Sanborn**, **Francis M. Kurtz**, **Allen S. King**, **Charles E. Brokaw**, **Horace W. McCurdy**, **Arturo Ponce Canton**; Secretary, **Whitworth Ferguson**; Assistant Secretary, **Oscar H. Horovitz**; Treasurer, **Earl H. Eacker**; Assistant Treasurer, **Fearing Pratt**; Alumni Committee, **C. George Dandrow,**

Marjorie Pierce, '22, receives a Bronze Beaver Award: "One of a very few senior alumnae, Marjorie has been an active member and officer of the Association of M.I.T. Alumnae for most of her 55 years since graduation, a dedicated and enthusiastic worker for the M.I.T. Alumni Association and Alumni Fund, especially in her efforts on behalf of the Ellen Swallow Richards Professorship, and an inspiration to many young women and men." (Photo: Roger Goldstein)

Laurence B. Davis, Abbott L. Johnson, Theodore T. Miller, Hugh M. Shirey, Robert Tonon, L. Samuel Vadner. The election was unanimous. In the meantime, the many letters received by Parke and others are continuing to give us happy memories of a wonderful experience together.

Norman Joy Greene has invited us to stop at Vero Beach next winter. He has also reported that **William H. L. Jones** passed away on May 30 at Anaheim, Calif. The Greene's enjoyed their visit with the **Ray C. Ellis**'s at Islesboro, Maine, on the way back to Newtown Square, Penn. Norman flew to San Francisco in September for a Board Meeting of the Mayflower Society followed by a visit to the Hawaii Society and a tour of the Islands. They will be back in Vero Beach in October.

The Department of Athletics has written **John Molinar** of Randolph, N.H., informing him of **Mac McCurdy**'s most recent gift of two Fiberglass 4's for training purposes on the Charles River Basin. At Mac's request, they will be named the *Jack Molinar* and *Jake Jakobson* shells together with Mac's previous gift of shells and rowing equipment.

Frank Kurtz of Delray Beach enclosed an unusual tribute to **Frank Westcott** announcing the Frank Westcott Northeast Fall Regional Bridge Tournament being held at the Sheraton Boston Hotel in September. Frank was our national champion and Captain of the U.S. Team. The Kurtz family spent September in San Diego with their younger son and returned through the Panama Canal on the *Renaissance*.

Yardley Chittick has written a card from Pemaquid Point, Maine, showing the beautiful coast and lighthouse. He congratulated Parke on the success of the Reunion and the extension to N.H. He expressed the sentiments of all of us in stating that no Class has had a better President.

You have all received Parke's October letter for the Class bringing you up to date on our Alumni Fund activities with hopes for a large showing annually toward our 60th Reunion Gift. The **Fergusons** hope to see Parke and Madaline in January.

Oscar Horovitz has sent a notice of the death of **Yoshori Chatani** on July 19 in Tokyo. He was 80 years old and enjoyed a long and eventful life with his family.

Our sympathy is extended to the family of **Charles W. Tyson** of Santa Fe, N.Mex. Charles was an inventor of the petroleum refining processes of the Exxon Corp. and a former member of Baltusvol Country Club and Canoe Brook Country Club of Summitt, N.J. Also we send our sympathy to the families of **Thomas F. Williams**, Schenectady, N.Y., and **Eliphalet N. Read**, Chevy Chase, Md.

There are so many more Reunion stories which we hope to remember and pass along. Good health to you all. — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

23

A meeting of the 55th Reunion Committee was held at **Pete Pennypacker**'s house in Deep River, Conn., on September 9 last. After a delicious lunch prepared and served by hostess Doris P. we settled down to finalize, as for as possible, the initial plans. Attending were — Chairman **Royal Sterling** and Mary, President **Mapes** and Mary Lou, **Tom Rounds** and Marge and of course Pete and Doris. By this time you should have received and answered the first reunion bulletin. To meet just about everyone's wishes we have planned a two-night stay in Cambridge (free lodging in dorms if you wish) on the June 7 and 8 followed by three nights at the Lighthouse Inn on Cape Cod, making the overall time June 7-12, 1977. Stays at both or either are optional. This we believe will happily satisfy everyone. Also if either you or your wife don't like dorms you are free to stay where you desire in the Boston Metro area. The class banquet and quinquennial business meeting will be on Saturday evening, June 10.

Marge and **Tom Rounds** had a delightful cruise on the Baltic — Copenhagen to Leningrad and return to Copenhagen. The two-week cruise took us to Amsterdam, Hamburg, Kiel Canal, Helsinki, Leningrad and Stockholm. From Leningrad we took a fast overnight side trip to Moscow, by jet plane. Glad to have done this since it was most interesting — particularly the Winter and Summer Palaces in the former St. Petersburg. In my experience the Royal Viking Line is tops in everything.

William LaLonde writes that he still working with a consulting engineering firm on structural engineering. Hope to see you next June, Bill.

We are obliged to report sadly two deaths. **Carl D. Dippel** lately of Hillsboro, Tex., passed away on September 1, 1976. Carl was born in Newark, N.J., in 1898 and after graduation became associated with Dippel Shade Co., a family business. Later he served as staff accountant for Sessions and Gentry of Hillsboro and a tax accountant with Peat, Marwick and Mitchell of Houston. He was active in Masonic, Kiwanis and Y.M.C.A. work with boys.

Colonel **Clark Kittrell** of Memphis, Tenn., passed away on January 26, 1977. Colonel Clark spent his entire career in the U.S. Army. He entered M.I.T. after graduating from the U.S. Military Academy in 1917 and received his B.S. in civil engineering with our class. He was commissioned to the Corps of Engineers and after service at Corpus Christi, Tex., and Fort Oglethorpe, Ga., he was an instructor at West Point in mathematics. His later work was spent in responsible charge of many flood control projects on the Ohio, Mississippi and Missouri Rivers. He served in World War II in North Africa, Italy and France receiving the Legion of Merit, the Oak Leaf Cluster and the Bronze Star for his engineering work in South America. He was a member of two professional societies, the Society of American Military Engineers and the American Society of Civil Engineers. — **Thomas E. Rounds**, Secretary-Treasurer, 990A Heritage Village, Southbury, Conn. 06488

24

Our Florida flamingos will be strutting again at the Sixth Florida Fiesta on January 24 and 25, 1978 at the Limetree Inn, Sarasota. **Dick Shea** is the maitre d'hotel at 255 Inner Drive East, Naples, Fla. 33595. **Clint Conway** is his deputy at 805 Maximo Ave., Clearwater, Fla. 33519. Alumni records indicate 29 classmates living in Florida. Activities will feature a banquet at the Limetree, harbor boat ride, dinner-theater at the Golden Apple, and the relaxation of sun and beach. And, for the opulent, shopping at the fabulous St. Armands Key and its posh shops.

We regret to report the loss of a renowned member, **Carl F. Muckenhoupt** (Captain U.S.N.R. Retired) on August 19, 1977, in Newton, Mass. He received an A.B. from Williams College in 1922, and S.B. in electrical engineering, and Ph.D. in mathematics from the Institute. Carl was Chairman of the Physics Department at Northeastern University until World War II interrupted. From 1946 to 1959 he was Chief Scientist with the Office of Naval Research in Boston. In 1959 he returned to Northeastern as Dean of Research, and he retired in 1966. More people knew him through his hobby than his professional career. He was an enthusiastic radio amateur, from age 12 when he received his first license until his death. He was a member of the American Society of Engineering Education, American Physics Society, Sigma Xi, Eta Kappa Nu, Phi Beta Kappa and Tau Beta Pi. His daughter, Joanna Enzmann, '58, was awarded an S.B. in mathematics and lives at 29 Adams St., Lexington, Mass. 02173. For the class, we extend our sympathy to Sarah and the family.

Paul Schreiber and Louise apparently fly south in the winter from Midland, Mich., as a note reads that they enjoyed attending the 1977 Second Florida Festival and are looking forward to the third. They also enjoyed an evening meeting of alumni at the Midland Country Club, hosted by Herb Dow, '52.

We were saddened by the sudden death of Velma, wife of **Gordon Billard**, on August 29, 1977. They had been tripping in Europe, when she was stricken in Rumania. With great difficulty, they returned to New York City, where she shortly succumbed to insidious pneumonia.

The Alumni Officers' Conference at M.I.T. on October 7 and 8 was attended by **Frank Shaw** and Barbs, **Ed Moll** and Rene, **Irwin Sizer, Jack Cannon, Herb Stewart, Dick Lassiter, Ray Lehrer** and **Russ Ambach**. The highlight was the dedication of the new Huntington Hall (nee 10-250), Alumni Headquarters, and the Margaret Hutchinson Compton Gallery. The *Review* kindly hosted class secretaries at a sumptuous breakfast Saturday. The *Review* is most anxious to establish a system that will assure receipt of its issues by surviving spouses. Your suggestions are seriously solicited immediately!

Bill Correale reports from New York City that he never had it so good in retirement, running back and forth as a consultant to the Polytechnic Institute of New York on occasion. — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline Mass. 02146; **Herbert R. Stewart**, co-Secretary, 8 Pilgrim Rd., Waban, Mass. 02168

25

Having just returned from Cambridge and the Alumni Officers' Conference, I can report that others from our class in attendance were **Jim Howard, Will Gardiner, Sam Spiker** and **Courtney Worthington**. The highlight of the first day was the dedication of the new Huntington Hall (10-250) and the dedication of the Alumni Center in Building 10. Details concerning these events appear elsewhere in the *Review* so let me only say that Huntington Hall has remained essentially unchanged since 1916, and as it appears now — completely refurbished and air conditioned — is the result of the donations of the alumni. About 85 named chairs appear in the hall. The executive committee of our class voted last June to give $2,000 from our treasury to the Alumni Fund and as a result one of the chairs is named for the class of 1925. **Sam Spiker** has his name on one of them, also. Ten other classmates' names were listed on the brochure distributed to those in attendance as having given to the Huntington Hall and the Alumni Center fund. It is not too late to donate to this fund. Just note when you make your next gift to the Alumni Fund that it is to be so used.

On the second morning of the Conference I set out to attend the Class Secretaries' breakfast meeting only to discover that in the confusing room arrangement at the Student Center I was at

a meeting of Estate Secretaries. Since our Estate Secretary, **Harrison Browning**, was not present I stayed on and will report to Harrison. It was interesting to learn that it is now possible for an alumnus to establish at M.I.T. a life income trust starting with a sum as small as $5,000. The setting up of the William Barton Rogers Pooled Income Fund makes this possible. If details regarding this matter are desired, inquire of **Harrison Browning** or write to Hugh Darden, Director, Office of Planned Giving, at the Institute.

My loyal correspondent, **Kamy Kametani**, writes that he and Hisako finally took their 50th wedding anniversary trip to Europe last August. They left Tokyo on August 2, flew by Air France to Anchorage, Alaska, over the North Pole to Paris, returning home on August 13. His tour covered Paris, various cities in Switzerland, Rome and London. He describes the highlights of the trip as the visit to Chateaux Chambord along the Loire River in France and the cable car ride climbing to Chamonix-Mont Blanc (4,807 m.) at Aiguille du Nidi (3,842 m.) Kamy's next target is the 55th Class Reunion in 1980.

I am sorry to have to report the passing of another classmate. **Elizabeth F. Aub** of Belmont, Mass., died at the Massachusetts General Hospital on August 3, 1977. She was the widow of Dr. Joseph C. Aub, an internationally known cancer researcher. Mrs. Aub was well known in her own right. After graduation from Bryn Mawr she came to the Institute and received her degree in architecture with our class. She was a long-time member of the board of overseers of the Shady Hill School in Cambridge. Also, she was a key figure in the development of the Cambridge School in Weston, Mass., where her architectural talents were applied in the design of one of the coeducational secondary school's dormitories. Another of her interests was the Window Shop, Inc., a Cambridge institution founded to help European refugees find employment in this country. She was an official in this organization for many years. Mrs. Aub was an accomplished musician, her favorite instrument being the cello. Also, she was an ardent gardener. She leaves three daughters, two brothers, a sister, and eight grandchildren. — **F. Leroy (Doc) Foster**, Secretary, 35 Woodland Way, P.O. Box 331, North Chatham, Mass. 02650

26

The Alumni Officers' Conference overshadows all else we have to tell you about this month. Several members of the Class attended, but there were hundreds there, so we never were able to get together as a group. Class Vice President **Bob Dawes**, and Reunion Chairman **Don Cunningham** were there with Evylyn and Mary and of course Liz and **Jim Killian** were present. **Dwight "Deke" Taylor** was present but I did not see Mary and only caught up with "Deke" for a few minutes at the first session. **E. Newton ("Bull") Roberts** was up from Jacksonville, Fla., where he is President of the M.I.T. Club. With him was his daughter from Atlanta. The Jacksonville Club is very active under Newton's guidance, and had Professor Ira Dyer, Head of M.I.T.'s Ocean Engineering Department, scheduled for a talk on "The Use of the Ocean" for their next meeting.

At our Friday afternoon session there were five workshops and your secretary chose the one of the Educational Council for two reasons. In our many years of activity in the Alumni Association we had missed this; and our right hand man in the Sailing Pavillian fund drive, Joe Edwards, '72, is now Director of the Educational Council. We acquired a new insight into M.I.T. strategy in maintaining a continuous flow of high quality in the student body in the face of ever rising costs, combined with attractions by other institutions who also seek the quality student. We all know that tuition has skyrocketed ($4,350 vs. $200 in our Freshman year, $275 when we were seniors) but so have living expenses, medical fees, personal and travel costs. (Books are now $280 vs. our tuition of $275.) The total budget for a careful student is eight thousand bucks! It takes a lot of scholarship dollars plus about an equal amount of self-help for a needy student to make it. With a lot of alumni support they are making it, but it appears to be a continual massive effort to do so, and there seems to be nothing wrong with that. After the workshops the "new" 10-250 and Alumni Center was dedicated. I put "new" in quotations because it is still 10-250, but more than face-lifted. *All* the seating has been replaced, many chairs with alumni names on the backs indicating a chair gift (understand there are a few still unnamed if you want one or a few). The whole place is carpeted which contributes to the accoustical excellence and the sound system is superb. Air conditioning is all new and up to today's standards. Do you realize that 10-250 was only six years old when we entered but it is now 61? About time for modernization, but isn't it wonderful that the room itself is still so good; and by the way it is called "Huntington Hall." On the first floor of Building 10, the exquisite new Margaret Compton Gallery was also dedicated with a wonderful exhibit of photographs of the Compton years prepared by Warren Seamens and his crew from M.I.T.'s Historical Collections. Quite a lot in one afternoon.

On Saturday, the star event was the first Robert H. Richards Alumni Lecture by Frank Press, Science Adviser to President Carter. Prior to his Washington assignment Dr. Press was Chairman of M.I.T.'s Department of Earth and Planetary Sciences. My only comment is that Dr. Press had us on the edge of the new chairs in 10-250. He has the ability of discussing the nation's technical problems in terms that even I can comprehend.

A notice of the death in June, 1976, of **Lebaron (Barry) C. Colt** brought back fond memories — one of which was the day he brought his aunt, Ethel Barrymore, into the analytical chemistry laboratory.

A thoughtful letter from John Pitkin, '37, enclosed a clipping telling of the death of **Eugene Nowlen** in Laguna Beach, Calif. He was an architecture graduate, and parton of the arts, and we did not personally know him but I'm sure our architectural classmates will. This brings to mind that Sunday's *Boston Herald* carried a story about a huge new insurance building in Manchester, N.H., for which **Bob Dean** is the architect. Still going strong! I'd wanted to tell you about a new ferro-concrete boat that recently went aground here in Rockport during a wild North-East storm. I'll save that for next month but will say that the craft was miraculously saved. With that a Cheerio and good night. — **George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

27

Tom Knowles wrote **Dike Arnold** describing his return trip from the reunion, still attired in the reunion "uniform": "Never traveled in a red coat before — it's something else! Before my baggage arrived at Cleveland I had four walk-up clients — two queries for rest room locations, one for a newsstand, and one plea for Alleghany Airlines." I can't resist adding one reunion story of my own. I had been observing to Marion the increasing difficulty we have in recognizing each other as the years change us. At the reception at the President's House I caught a glimpse of someone walking toward me who looked very familiar in his red jacket, but whom I could not place — until I realized that I was walking toward a wall mirror.

Joe Harris, one of the most regular attendants at reunions, missed the 50th. He writes: "It was a great regret to me that illness kept me from the reunion. There were so many who I missed seeing. Ann and I had fully planned to go, but in May I learned that my kidney condition was such that I would have to begin dialysis treatments. Getting used to this took up most of June, but I can now lead quite a normal, active life." We'll look forward to seeing Joe and Ann at the 55th.

Joe was good enough to share with me, and the class, a card he received from **Amund Enger** in June. Amund wrote: "**Ken Smith** is visiting us on the tail-end of a year in Europe, so we have had a quiet mini-50th reunion here in La Rippe [Switzerland]. I have just had a hernia operation, so I'm unable to travel at present, I'm also unable to

A 1977 Bronze Beaver is awarded to Dwight C. Arnold, '27 (left): "As past President of the Association, as a member of the Corporation, as Chairman of his 50th Reunion, as Director of his Fraternity and in countless other ways over the past half century, Dike's leadership and support have been a source of strength to M.I.T." (Photo: Roger Goldstein)

mow the lawn, so Ken got roped in; he seemed to enjoy it, though. Frances and I are both in reasonably good health and enjoy life here and in Portugal, where we spend the winter." I have not heard directly from Ken Smith about his European travels, but again I am grateful to another classmate, **Russ Westerhoff**, for passing on what he has learned. Ken went to Dubai on the Persian Gulf in July of last year at the request of the State Department to be part of an international group judging a hospital competition. In August, he joined Meg in Vermont for a trip through New England, New Brunswick, and the Province of Quebec. Thence back to New York and off to Scotland to stay with cousins for a few days. They rented a car and saw the North Highlands, including places Ken had been to when he spent a year in Scotland at the age of 5. In September they went to London, where their stay was prolonged by an accident in which Meg hurt her elbow and required an operation, convalescence, and physical therapy. They met Meg's brother in London and then traveled to Egypt and Athens. They spent a month at a house on Hydra Island (in the Aegean Sea). In April of this year, Ken wrote that they were en route to Rome from Tehran after three months' travel in Egypt, where they saw their first sand storm. From Rome they were to go to Venice and then to Switzerland. Don't we all envy them.

I have a batch of brief gleanings from the Alumni Fund envelopes. **Winfred Witham** writes that he has been engaged in a never-ending construction lawsuit "which requires too much of my energy and dollars." . . . Edith **Bugbee (Stu**'s widow) notes that their daughter is a travel agent in Newark, Delaware; one son is an architect in Philadelphia and the other son is a mechanical engineer for DuPont in Camp Hill, Penn. . . . **Pinky Pinkerton** reports that he and a friend have formed Harkness-Pinkerton, General Contractors, in Daytona Beach. After losing his wife, he was married in 1972 to the former Evelyn Bisbee Rand.

Harriet and **Joe Yates** spent last winter in Tucson. . . . **Marcus Robbins** is still in Weston, Vt., but with the increasingly long winters has been spending more time at Daytona Beach. . . . **Joseph M. Galeota** retired this year after 48 years with the City of Boston Traffic Dept., the last 20 years as Traffic Engineering Director. He and Kay are planning to spend some time traveling.

Frank Cahill, who retired 16 years ago from the Boston Naval Shipyard Design Division, keeps busy with woodworking and carpentry. . . . **Jack Boyle** is still doing test borings and test wells for various engineering concerns in the Greater Boston area. . . . **Frank Massa** is still Board Chair-

The Story of Chungsoo Oh

The boy was born of a peasant family in the middle western part of the hermit kingdom of Korea in 1899. At the age of six he was sent to a school to learn reading and writing of Chinese literature. Two years later he was taken into a modern grammar school established by a group of progressive townspeople to provide an education comparable to that of the Western world.

At the age of 13 the boy graduated from primary school. But due to the poverty of his family he was unable to go to middle school; he went to work on his father's farm. A year later he learned that a middle school in Seoul was operating a small textile mill to train students after school hours, and so the boy was able to take a weaving position to provide himself with food while attending this school; free dormitory rooms were provided by the school.

In grammar school one of his teachers had showed the boy picture post cards of modern buildings and installations in America, saying that the land was enormous but people were comparatively scarce. This had suggested to the boy that he should go to America to find better opportunities; but it was a mere dream, for the boy by far lacked the money to travel there or the possibility of obtaining the government's permission to go.

"... To Jump Up from the Dreadful World"

One of the boy's classmates in Seoul was K. E. Kim, whose father had money enough to send his son to America. Kim whispered one night to the boy that he was going to the U.S. through a secret channel, and that he would look for chances to help the boy, too, to come to America. It was very nice of Kim to think so much about him, but the boy could not believe that Kim would actually find a way to help him.

Then two years later a letter came from the U.S.A.: "At last I found a gentleman who will buy you a steamship ticket from Shanghai to San Francisco if you can manage to come to Shanghai," Kim wrote. The boy, overwhelmed by the surprising news, recalled the proverb that "even if heaven crashes, there could be a hole found for jumping up above," and he decided that heaven had indeed given him the chance to jump up from the dreadful world.

The problems now were to find the money to go to Shanghai and to escape the network of police. The boy's father was willing to sell the oxen used for all the tilling and transport on his farm in order to provide the travel expenses; the middle-sized bull yielded about 80 won ($40 U.S.). And one of the boy's former teachers provided the itinerary for a secret way to Shanghai. So the boy was ready.

It was the first time he was to travel so far into an unknown country. He could not use spoken Chinese, although he could read and write some literary Chinese; his intention was to communicate in writing when necessary during the trip.

Six Letters and 14 Months in Shanghai

The first hurdle was the national boundary of Korea and China, watched over by Japanese Customs officers. When the border was near, the police on his train asked the boy where he was going; the boy replied that he was visiting relatives in Shiniju, a Korean city across from the Chinese city of Antung, Manchuria; and he was allowed to pass. Then, at the inn designated on the itinerary, sympathizers of Korean exiles helped the boy to change money and buy a steamship ticket to Shanghai.

So it was that, about two weeks after leaving home, the boy landed in Shanghai, where he was led to a Korean boarding house. From there he wrote to his friend Kim, notifying him that he was waiting for the help which Kim had promised.

It would take at least two months to receive a reply from the U.S.; when it came, Kim promised that the ticket for the steamship to San Francisco would be sent within a week.

But after three weeks nothing more had been heard from Kim, and the boy wrote again. Kim replied that the letter containing the steamship ticket had been returned because the addressee could not be found. So the boy took the advice of a friend and gave the address of the Chinese Y.M.C.A., where mail was put out on a table for each recipient to claim his own. But the boy did not know that registered mail was held in the safe and the notice of arrival posted on a bulletin board. So the letter containing the steamship ticket, being registered, was overlooked and eventually returned.

Finally Kim wrote that the money had been sent through a bank, which would notify the boy at the Y.M.C.A. address when it was available. A month later came a letter in Chinese; the boy went to the bank to find that a sum of money was waiting for him. It had been there for three weeks, and two letters of notification had been sent; the money was to be returned to the sender as unclaimed within another week. So now, after 14 months, the boy was finally ready.

Eluding the Police and Finding the China

The money was enough to buy a steerage cabin in the *S.S. China* to San Francisco, and now the boy had to pass a health examination before he could board the ship; the company must certify to the U.S. that its passengers were healthy.

The ship's doctor found that the boy's eyes were reddish and said he should have treatments, costing $10, on board the ship during the passage. It was a big new problem; how can the boy get $10 for the treatment? His pockets were almost empty except fot the few Mexican dollars which he had saved for barge fare to reach the ship; he could not take the motor boat lest he be caught by the Japanese secret police who frequently rode it.

Finally the boy remembered. In a church gathering he had met a gentleman by the name of Hahn, an elderly man, a political exile, who loved all Korean students. The boy visited Mr. Hahn in his office and told him the problem, promising to send back the $10 out of money that would be waiting for him in Honolulu. Mr. Hahn smiled, gave $10 to the boy, and wished him good luck.

By now it was 11:00 a.m., and the steamer was to sail from Woo Song Port at 10:00 p.m. The boy had hoped to find others who would help him reach the ship, but the waiting room was empty except for a lady who clung to the boy, begging him to help her reach the steamer. She was also a Korean exile; she turned out to be the wife of his primary school teacher, going to the U.S. to join her husband. To take care of her certainly was going to be burden, but the boy could not refuse.

Neither the boy nor the lady were well versed in Chinese, and neither knew the way to Woo Song. They must reach the steamer before dark. Together they hurried to the railroad station, waited in line to buy a ticket, arrived an hour later in Woo Song, and walked a mile from the station to the wharf. No one knew where the *S.S. China* was to be boarded; the ocean-going steamers were scattered all over a vast harbor, so far from the muddy shores that one could not see the names on the ships at all.

Then the boy discovered a man coming up the shore clad in white uniform and white cap. This must be a customs officer, a European. The boy mobilized all the Eng-

Chungsoo Oh, '27 ("the boy" in the story on these pages and the man in the picture above), entered M.I.T. from East Side High School, Denver, Colo., in September, 1924, after one year of preparatory studies at Boston University.

A simple statement — nothing unusual about that.

But behind it lies a story of sacrifice, effort, suspense, and — ultimately — outstanding success.

That story was told to Chungsoo's classmates during their 50th reunion last June, and now it is told for all readers of Technology Review.

lish he knew and asked, "Sir, where is the steamship *China*?" The officer understood; he pointed to a ship far away on the horizon: "The steamer with smoke coming out of the stack," he answered. The boy understood the words "smoke" and "stack," and saw that only one ship was ejecting smoke. Now he knew their destination.

Further down the shore was a small house, where an elderly Chinese gentleman was sitting in the yard. As the couple approached, the man saluted and offered them stools on which to sit and tea to drink. The boy, who could not speak Chinese, pulled out pencil and paper and began a written conversation, asking assistance in finding a sampan to carry them to the steamer. The old man nodded and sent his wife to a neighbor, who returned and offered to make the trip for one Mexican dollar per person, a very reasonable fare. So it was that the boy and the lady arrived on the *China* by about 6 p.m. and were guided to the steerage cabin.

"Sing Ming," and the Ordeal Ends

After supper the boy walked to the upper deck, where he saw in the waiting room two stout Orientals in western-style clothing. Japanese detectives? He thought so — and returned quickly to his room in steerage. He stayed there, quite seasick, during two days' journey to Nagasaki, where the ship stopped for six hours to load coal. In fact, he did not come out of his room at all in Nagasaki, and he did not meet any police.

The deck-boy said that the boy must prepare himself for possible interrogation by Japanese police in Yokohama. So the boy made an arrangement with a fellow passenger to borrow a suit of Chinese clothing, Cantonese style of dark brown oilcloth. Thus disguised as a Chinese, the boy enjoyed the scenery from the *China*'s decks in Yokohama, until suddenly the cabin boy appeared with a Japanese gentleman in western clothing. "Sing Ming," said the cabin boy ("Your name, please"), handing the boy pencil and paper. The boy understood. Calmly, without speaking, he wrote down his name in Chinese, and the detective turned away without hesitation.

The ordeal of possible arrest by the Japanese police was finally over.

"Carry Money" and a Tour of Paradise

The boy still had two more gates to pass through. U.S. immigration authorities required that each passenger have at least $50 in cash when entering the country — "carry money." Kim was to have arranged with a friend in Honolulu to hand over this sum to the boy when the steamer called there; but it was rumored that some students had been discovered by customs officers and forced to return to Shanghai because their "carry money" was carelessly handed over in Honolulu. Passengers had not been allowed off the ship in Japan; would they be permitted to land in Hawaii?

Then, of course, there would be the difficult question of immigration, including the need to prove literacy, when the ship arrived in San Francisco.

A happy and surprising announcement: the ship would stay in Honolulu for ten hours, and passengers would be allowed to land! Among the huge crowd which came to welcome the ship were many Koreans, waving hats and handkerchiefs and saluting their countrymen. Was Yong Man Park, with the boy's "carry money," among them?

Thinking that Mr. Park could find him better, the boy waited on the ship; and by and by Mr. Park did come and took the boy out to show him around the city. Mr. Park was a well-known Korean patriot, enthusiastic about the education of Korean young men: Korean students who were able to come to the U.S., he said, were a privileged group; they must learn well so that they could be leaders in the restoration of independence to the father country.

The boy was dazzled by Honolulu, the sky and water blue and bright, every plant and tree with flowers or fruits, the people in beautiful clothes of many different styles, looking gay and happy. What a contrast with the scenes of Shanghai! The boy almost forgot about the difficult gate of immigration which lay ahead.

"You May Go Out Now"

When the *China* arrived in San Francisco, the Koreans, who did not have passports, were taken to Angel Island and housed in a small compound surrounded by barbed-wire fence. For two days they were examined by doctors for contagious diseases, and on the third day they were to be examined by immigration authorities for admission to the U.S.

Each passenger was called by name. As the boy entered the room, the officers looked at him very critically, ascertained his name, and examined his picture to see if it matched with the boy. Why did he come to the U.S.? To receive education, replied the boy.

"Who bought you the ticket to San Francisco?" The boy hesitated; if he tells the truth he might not be admitted.

"Was it your father who gave you the money to buy the ticket?" asked the interpreter, seeing the hesitation. Yes, that would be a good answer, thought the boy; so he replied, "My father."

The boy showed his certificate from the Kyoung Shin Middle School and explained that he had waited two years in Shanghai to be able to come to the U.S.

"Why are your hands so rough and hard?" asked an officer, feeling the boy's palms. So the boy explained that he had learned to play baseball in Shanghai, and the stiff palms were from pitching and catching the ball.

Then the boy found a printed slip of paper and a pencil on the table in front of him. The paper said in Korean, "Pick up the pencil in front of you and give it to the officer sitting beside you." The test for literacy, the boy thought, and did as he was instructed; but it seemed absurd, because almost every Korean, no matter how illiterate, could read such simple words.

The officers discussed something in English, and suddenly the interpreter said to the boy, "You may go out now." Did that mean that he should return to the waiting room? No, said the interpreter, pick up your luggage and go to San Francisco.

He was free!

The Editor's Epilogue

Chungsoo Oh recalls how Korean exiles in Honolulu told him that the U.S. was "a land of opportunity, where anyone with health and ambition could mold his success according to his desire and ability." And so it was. Chungsoo's friend Kim and his sponsor, a Mr. Park, awaited the boy's arrival by train in Sumner, Wash., on August 16, 1917 and Chungsoo says that "the real adventure of his life was to begin."

Chungsoo was graduated from Sumner Grammar School in 1919, having worked on Mr. Park's farm to earn his board and room. That fall he went on to Broadway High School in Seattle, supporting himself with $100 in summer earnings from a sawmill job near Sumner and a newspaper delivery route. It was then that he resolved to become an engineer, to bring knowledge of technology home with him to Korea; and he determined to study in Cambridge — either at Harvard or M.I.T. To be nearer Cambridge he moved to Denver, where he worked as a domestic for two years while taking five subjects each semester and graduating with a straight-A record from East Side High School. His first choice was Harvard, because it offered more scholarships than M.I.T.; but he did poorly on the college entrance test in history — a blessing in disguise, he now thinks, because it resulted in his going to M.I.T. instead.

Chungsoo returned to Korea with his M.I.T. degree in business and engineering administration in October, 1927. Within six years he was Production Superintendent for the Heijo (Korea) plant of Corn Products Refining Co., and six years later he became General Manager of the Manchurian Corn Products Co., Antung, Manchuria. He is now one of South Korea's leading industrial statesmen, President of the Korean Trade Development Co., Ltd., Chairman of the Board of the Korean Arrowroot Fiber Craft Co., Ltd., and (for 18 years) Vice President of the Korean Traders Association. For three years after the liberation of South Korea, Chungsoo was Director of Commerce and Industry for the interim government; he has temporarily served as Minister of Communications and Minister of Commerce and Industry; and for 15 years he has been a member of the Council of the Korean Chamber of Commerce and Industry. — *J.M.*

man and Director of Engineering of Massa Products Corp., successor to Massa Laboratories, which he founded in 1945. . . . **Tom Scott** traveled last spring to Egypt, Israel, and Greece. Tom has retired, but his wife, Irene, has not. She is a judge on the Federal Tax Court in Washington.

August was a sad month for the class. In that month we lost **Howard Ferguson**, **Jack Eldert**, and **Bert Houghton**, all of whom had been at the Reunion, enjoying and contributing to the fun.

Howard looked the picture of health at Wianno; he was playing golf, as usual. He retired from Standard Oil (Ohio) in 1968, after 39 years with the company in Cleveland. He was Wholesale Sales Manager at retirement; he had previously served as Lubricating Sales Manager and as a plant manager. Since 1971, he and Cele had been spending the winters in Apollo Beach, Fla., and the rest of the year in Henderson, N. C. He was a past president of the Cleveland M.I.T. Alumni Club and had held memberships in various trade associations and golf clubs. Besides his wife, Cele (a classmate of my sister at B. U.), he leaves a son and daughter, and four grandchildren.

When we left **Bert Houghton** in Cambridge after the Reunion, he was planning to stay on in Boston for a visit to the Lahey Clinic for what I understood to be a minor eye ailment. Bert had been a geophysicist with Amerada Petroleum and was a member of the team at Almagordo working on the Manhattan Project. He had done some schoolteaching but retired in 1965, shortly after his wife died, and moved to Ventura, Calif., to be near his only daughter. In 1970, he married Kathleen Elton, who survives him, and moved to Medford, Ore. In addition to his wife and daughter, he leaves three grandchildren.

Jack Eldert had also remarried; his wife, Evelyn, died in 1967, and in 1975, he married Barbara W. Dark. He had retired in 1975 as Executive Vice President of Machine Parts Corp., but continued to serve the company thereafter as a part-time consultant. He was a member of the American Society of Mechanical Engineers, the Providence (R.I.) Engineering Society, and other organizations. Besides his wife, Barbara, who is an active real estate broker, he leaves two daughters, a son, six grandchildren, and two step-daughters.

I have belated reports of two other classmates who are gone. **John A. Adams** died in February, 1976, in Portland, Ore. He served during World War II as a colonel in the U.S. Army, and won a commendation ribbon.

Max L. Libman died in August, 1976; he held a master's degree in law from Washington College and was a patent attorney for Army Ordnance and, later, for the Bureau of Standards.

Your secretary, after a full year of retirement, is back at work, more or less, with the Controller for United Way of Westchester. I work only five half-days a week, but the job gives me a routine and a chance to wear out my uniforms (suits and white shirts). — **Joseph H. Melhado**, Secretary, 24 Rodney Rd., Scarsdale, N. Y. 10583

28

Outstanding recognition has come to another of our classmates. At the Spring Convocation of the Sir George Williams Faculty of Science of Concordia University in Montreal, **Chuck Carter** was awarded an honorary degree of Doctor of Laws and also delivered the Convocation address. The honor came, in the words of the Rector and Vice Chancellor, as a result of his "distinguished career as a statistician." Chuck retired from Bell Canada in 1972 and subsequently accepted a temporary appointment for two years with the Canadian Conference Board. More recently he has, together with other statisticians, been working toward the establishment of the Statistical Society of Canada. Keeping busy with golf and gardening, Chuck and Phyllis are looking forward to attending the 50th Reunion next June. . . . A greatly appreciated letter from **Jim Allan**'s widow, Virginia, tells of Jim's employment with the government in the Purchasing Department concerned with motor equipment. Subsequently, until ill health necessitated his retirement, he had his own business called "Allan Products Co." The final 13 years of his life were a patiently endured bout with illness under Virginia's devoted professional nursing care. Virginia plans to stay on in Washington for the foreseeable future, possibly returning to her beloved profession in clinic work.

Mary and **Max Parshall** write with enthusiastic anticipation as they contemplate the approach of the 50th reunion. They "have been counting days ever since last reunion," looking forward to their return to McCormick Hall and to adding to their treasure trove of nostalgic photographs. Mary commented that back home in Montana Max will "cut quite a figure in his red coat." . . . From even farther away — Japan — comes a note from **Shikao Ikehara** saying that he expects to come to Reunion and in the meantime is teaching at three colleges. . . . **Mac McDermott** was smart in recognizing that the envelope provided for the reservation card in the first 50th-reunion mailing was large enough to invite a response with personal news. Consequently a chatty letter reports the uprooting in 1974 from his and Marjorie's 23-year residency in Darien, Conn., and the subsequent enjoyment of their new home at South Orleans on Cape Cod. From this base they sally forth to visit daughter Pat with her Janet and Susan living and attending college in Marin County, Calif., or fly overseas to visit their son, Bob. Still employed with Bechtel Corp., Bob and his wife, Randi, are living in London and vacationing in the French seacoast town of Bandol near Toulon. Mac and Marjorie have also visited Russia and the Canary Islands. On the Cape, Mac is active as a Director of the newly formed M.I.T. Club of Cape Cod but regrets that no other '28-ers have yet joined this group of approximately 100 alumni. How about it, you '28 Cape Codders?

Your Secretary and Florence joined **Jim Donovan** and Frannie, **Morey Kiegerman** and Claudia, **Abe Woolf** and Ruth, **Newt Foster** and **Dick Rubin** at the October Alumni Officers' Conference on campus. The new Alumni Center was the focus of attention and the refurbished and modernized Huntington Hall — familiarly known as "Room 10-250" — was dedicated. Thus far, five of the purple upholstered chairs in Huntington Hall have plaques attached bearing the name of a member of the Class of 1928, thus affirming that, in loyalty to M.I.T., a gift of $2,000 was given to the Institute by or in the memorialized name of each of these members of 1928. There is still an opportunity for others of '28 to join this group, thus increasing our 50th Reunion Gift, possibly qualifying for a Challenge '78 additional $1,000. All these gifts will make evident to alumni and students of the future the gratitude of '28-ers for what M.I.T. has meant in their lives.

Prior to the time you are reading these notes, you should have received the second notice of our reunion. As of this writing, 172 classmates and spouses have expressed thier intention to join us in June. In addition, 66 others have said they hope to attend. Those of you who are still undecided should act promptly in indicating interest, as subsequent mailings about the reunion will be sent only to those who have responded to these two announcements. . . . By this time your mail has also brought you a questionnaire from **Herm Swartz**. Do fill out the form and return it to the Alumni Association in the provided envelope immediately — whether or not you are attending the reunion — as only thus can we have a full record of the Class and only thus can you qualify to receive a copy of our 50-year Class Record Book.

With regret we add the names of **Dudley Collier** and **Mary Manley** to our obituary lsit. Dud passed away on August 22, 1977, and Mary on June 20. In a phone conversation with Dud's widow, Mary, we learned that, following his January heart attack, the implantation of a cardiac pacer and the elimination of alcohol and smoking had helped Dud to continue an active life. Since his retirement he has been particularly occupied with the grounds and garden surrounding their 1678 salt-box home, making of them a showplace — especially in preparation for the wedding of their daughter, Jill. All was in readiness for the celebration in the historic village church in Billerica, Mass., and the family reunion at home; Dud was driving to the bus station to pick up Jill when he became involved in a head-on collision. The pacemaker was still functioning futilely when he was declared a casualty. Dud's funeral was the day preceding the wedding. To Mary in Billerica, Dud's son in Oregon, his daughter in California, and Jill now living in Connecticut and teaching preschool handicapped children, we send the sympathy of the Class. Mary Manley's daughter, Prudence, is now a resident of California; to her also we extend our sympathy and the hope that we may hear more from her about our classmate, Mary. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, Mass. 01890

29

A brief note comes from **Bill Aldrich** as follows: "We are getting ready for a Western Class of '29 mini-reunion here in Billings, Mont., scheduled for the Labor Day Weekend." Bill acted as host to several members from North as reported by **Bill Baumrucker** in this column.

A note from **Frederic L. Bray** states, "I was forcibly retired at age 69 without pension. At present, I represent a small Maryland neighborhood in a fight against 'Ma Bell' and F.C.C. over rates for toll charges for infinitesimal distances across the state line to Delaware."

George J. Burke, who has had a distinguished engineering career, has found time to be involved in the civic and political life of his community in the Salem-Swamscott area. He has been a Board Member of Public Works Department for 14 years. Some of the highlights of his career are: Chief Engineering and Inspector during the construction of the Sumner Tunnel in Boston, worked on the Sudbury Tunnel in Natick, the Fort Halakird Tunnel in Maryland, and the office tunnel for the U.S. House of Representatives in Washington, D.C. George spent about ten years working for the federal government and when World War II ended, he went to the Dominican Republic as general superintendent for a huge program involving the construction of roads, dams, pumping stations and sewer and drainage lines. His hobbies include travel, having visited Russia, South America, and Europe. "Of all the places I've visited," he says, "St. Croix in the Virgin Islands remains my favorite."

Anthony Standen writes: "Although I was in Course X (chemical engineering), at present I am studying electric power in cooperation with the League of Women Voters, which now admits men, in their fight against power companies on rates. I find that power companies try to justify their rate setting on more 'nonsense' items than anything else I ever had to do professionally."

George A. Crandall is continuing his business (wholesale sporting goods in Casper, Wyo.) which he started in 1945, with no thought of retirement as yet. He has, however, retired from the Army Reserve as a Colonel as of 1966. His health is excellent in spite of his age. He and his wife and youngest daughter are planning a trip to the Pacific islands to visit where he was stationed in World War II. George and his wife Willa attended our 40th Reunion at Chatham Bars Inn and are planning to join us at our big event of our school life, our 50th Reunion (again at Chatham Bars Inn) a year from next June. He sends his regards to all.

Norman Wickstrand was the leader of a nature walk on a Saturday last summer, sponsored by the Litchfield, Conn., Nature Center. Norman is also a member of the Appalachian Mountain Club and an active member of Litchfield Hills Audobon Society.

Harold C. Pease has finally done what most of us have or are planning to do, by moving from a large house in Ridgewood, N.J., to St. Petersburg, Fla., escaping the cold winters of the North with a warmer and slow-paced life of south Florida. He had spent his winters in St. Petersburg for the past four years and he figured a permanent change would be more desirable with an occasional visit up North. "It was a big move," he continues, "and I was sorry to make it, but I fig-

ured it was for the best. It was quite a task getting rid of household items that had accumulated during the past 32 years. I have been here now for three weeks and still trying to settle. Thanks for your birthday greetings — I always look forward to receiving it." Harold was one of the members, along with your Secretary, of the first graduating class of Course XVII (Building Construction Engineering) now defunct, which has become a part of Course I.

After repeated prodding, we finally have received a note from **William Baumrucker**, President of our Class, as follows: "Retired life continues to be great! I am so busy, I don't know how I ever had time to work. I play tennis two or three times a week (when I get really old, I'll take up golf) and we do quite a bit of traveling. As you know, I took part in a couple of '29 mini-reunions which were staged in Montana and San Francisco together with **Wally Gale**, **Frank Mead**, and **Jim Fahey** accompanied with Ruth. Frank and Wally will tell you more about this. Doris and I have taken several trips this past spring and summer with **John Rich** and his wife, Aline. In February, we visited most of the Caribbean Islands, then in March, we went to the Virgin Islands, where **Tom Speller** and his wife Helen joined us. In May, Doris and I went to Europe with John and Aline for a month, driving around Germany, Austria, Yugoslavia, Italy, and Switzerland. A great trip and great fun." Bill says that the best way to see Europe is to go there, buy a car (preferably Mercedes-Benz as he did) and travel to any country your heart desires, and at the end ship your car home duty-free, since it had been used previously.

Stephen N. Dilworth writes, "Belated thank you for your Birthday Card, which I appreciate. Recently, I formed a little M.I.T. Club of Rassmoor (a retirement complex) with 11 members, representing classes from 1918 to 1937. We meet once a week for lunch. We have just returned from a month's trip to Russia, which was very interesting and enjoyable. We most certainly are looking forward to attending our 50th Reunion. I shall never forget our 45th, where Mynne (my wife now) and I attended (I was courting her then). Some of the boys and girls, headed by Helen Dinjian, campaigned on my behalf, convincing Mynne to say 'yes.' Before the reunion was over, Mynne gave her consent and we were married upon our return to Rossmoor where she lived also." — **Karnig S. Dinjian**, Secretary, 10 Ancient Highway — Plaice Cove, Hampton, N.H. 03842

30

This month both of our Fosters have reported in. **Dick Foster** retired several years ago from his job as a quality control food technologist at Campbell Soup Co. in Camden, N.J. Upon retirement he moved to Chatham on the Cape where he was conveniently located for attendance at our 45th Reunion. Those of you who attended the 45th will remember him as without much doubt the youngest looking classmate present. Dick's principal hobby is woodworking and restoration of antiques. He also works with Monomoy Community Services, Inc., a mental health related agency dealing particularly with the problems of young people. The Fosters' son Donald is president of Health Facility Planners, Inc., in Northbrook, Ill., and daughter Susan is Supervisor of Nursing at New England Medical Center Hospital in Boston.

As of several years ago, **Bob Foster** was a consulting engineer (building construction) doing business as Robert A. Foster Engineering Corp. in Concord, N.H. He has since retired but is still active on the Concord Zoning Board and Concord Building Code Appeals Board. The Bob Fosters' daughter, Karen, like the Dick Foster's daughter, is oriented toward nursing. More particularly, Karen is now a junior in nursing school. . . . **Ernie Fell** retired about ten years ago from the practice of medicine in Fall River, Mass., where he still lives. He reports that he is alive and well and enjoying life as a retired physician "walking around and about instead of to and from."

Hal Spaans is still enjoying retirement and keeps active by running seminars for Independent Telephone Co. employees about three times a year, as well as working with the Town Watch (area patrols) in Wayne, Penn. He reports having visited **Hank Halberg** who is also retired and enjoying retirement. . . . **Earl Ferguson**, like Hal, is a retired telephone employee having retired from New York Telephone Co. in 1970. He and Hilda enjoy traveling and are planning a cruise next spring from Puerto Rico through the Panama Canal to Los Angeles with stops at Balboa and Acapulco. Earl reads the *Wall Street Journal* every day and takes an occasional flyer in the stock market. The Fergusons' daughter Priscilla attended Middlebury College and before her marriage in 1970 worked for UNICEF as Director of Greeting Cards Promotion. Earl recently talked with **Bill Lodge** in connection with the 50th Reunion class gift.

We have a note at hand that **Bill Driscoll** died on August 28, 1977. Those of you who were present at the 45th Reunion may recall that Bill and Wanda were present. Bill was a sales representative for Joseph T. Ryerson and Son, Inc., for 25 years ending in 1969, with time out during World War II for a stint as a Lieutenant Commander in the U.S. Navy. After retiring from Ryerson he took a job with the Public Works Department in Framingham, Mass., from which he retired in 1975. It appears from the newspaper clipping about Bill's funeral that **George Shrigley** was one of the pallbearers. — **Gordon K. Lister**, Secretary, 530 Fifth Ave., New York, N.Y. 10036

31

A letter from **Emile Grenier** emphasizes that airbags in cars are "potentially lethal" and suggests that we write our congressmen to this effect and also ask our friends to do the same. This is a worthwhile cause and Emil certainly knows what he is talking about.

The Alumni Officers' Conference on October 7 and 8 was well attended and I understand several of our class attended, including **Howard Richardson**, but unfortunately yours truly didn't run into any of them.

A note from **Bill Hallahan** informs us that he is still enjoying his work as Treasurer and Senior Vice President of Fay, Spofford and Thorndike, Inc.

A newspaper clipping tells of the death of **Charles Straley** on September 1, 1977. He was mayor of Meriemont, Cincinatti, Ohio, having occupied that position for 16 years. Prior to that time, he was project engineer for Turner Construction Co.

Word has also been received of **Jack Kalman**'s death on July 2, 1977, after a long illness. Jack was a lieutenant colonel of the engineers and had retired after 25 years of service. Our deepest sympathy to both of their families. — **Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, Fla. 32757; **John R. Swanton**, Assistant Secretary, 27 George St., Newton, Mass. 02158; and **Ben W. Steverman**, Assistant Secretary, 260 Morrison Dr., Pittsburgh, Penn. 15216

32

Albert G.H. Dietz was named "Man of the Quarter Century" by the Building Research Advisory Board of the National Academy of Sciences. He received his award at a dinner in Washington, D.C., attended by many leaders in the building industry. Dr. Dietz has been a member of M.I.T.'s teaching staff since 1936. He was director of M.I.T.'s plastic research laboratory from 1946 to 1962. He was a member of the M.I.T. Committee for Space Heating with Solar Energy. Professor Dietz lives in Winchester, Mass.

Carroll L. Wilson conceived, organized, and directed the "Workshop on Alternative Energy Strategies." This international project was the joint effort of 75 experts from 15 countries. The report, published by McGraw-Hill is entitled, *Energy: Global Prospects, 1985-2000.* Professor Wilson says that all our work can be boiled down to a single message: The free world must drastically curtail the growth of energy use and move with wartime urgency massively out of oil into other fuels.

Byron James, '32

Byron E. James has retired as Chariman of the Board for McQuay-Perfex, Inc. He will continue as a Director and Chairman of the Executive Committee. Mr. James joined McQuay in 1949 as Chief Engineer. After serving in various elected capacities he became Chairman of the Board in 1969; 3,800 people are now employed.

Elmer H. Stotz is retiring as Professor of Biochemistry at the University of Rochester and will be advanced to Professor Emeritus. Dr. Orbison, Dean of U.R. Medical School, said, "Dr. Stotz is a scientific statesman of international scope who has provided us with an unbroken record of distinquished leadership in basic medical science. We shall sorely miss the scholarship, strength, and wisdom that have characterized his career at the Medical Center."

Royal B. Jackman writes that he has retired from Northrop Corp. in 1973. For the past year he has been President of Help of Ojai, Inc. a nonprofit organization of volunteers dedicated to aid people in need. The shift from strictly technical management to social service management has been challenging and fulfilling.

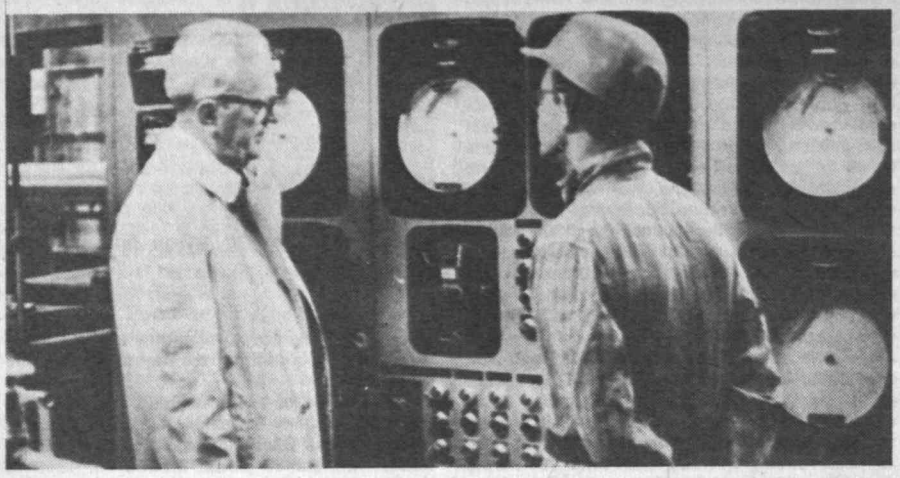
Frank S. Chaplin writes that he is building a retirement home near Washington, N.C., where his wife grew up. He has obtained a state professional engineering license and will continue consulting if there is a demand for his services. Otherwise he is less than a mile from Pamlico River with sailing and fishing available.

Howard R. Pyle informs us that he is nearing completion of his stint as Mechanical Consultant (HUAC) for Hercules, Inc.'s new country club facility. . . . **Edward E. Burritt, Jr.** tells us that he enjoyed the 45th Class Reunion. He hopes there will be more members for the 50th and suggests we meet at a resort near Cambridge.

I am sorry that I must be the bearer of sad tidings. We have received information that **Joseph E. Coffey, Jr.**, died on July 3, 1974. Also, Mrs. Sheldon informs us that **George T.E. Sheldon** died on November 30, 1975. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, Mass. 01907

33

Headlines, this time around, must be for our coming 45th Reunion at Chatham Bars Inn next June; and, surely for our genial President, **Dayton H. Clewell** (generally called Doctor, but to us, he is just Dayt). Dayt announces the location will be at the Inn as we have enjoyed the spot twice before, where golf and tennis, as well as swimming may be enjoyed. The weather has always been good and the accomodations the best, including the food, with a glaring exception; the Clam Bake leaves too much to be desired. Perhaps a fellow from the goiter belt might say the Bake is OK. Us Yankees say an emphatic no. Principal growl is that the Bake is ready a half hour before the guests are. So the schedule calls for arrival Friday afternoon, June 9, and ends Sunday afternoon, June 11. However, the Institute and the Alumni Association are planning many interesting activities on Campus earlier in the week. No doubt many fellows and gals may elect to spend some time in Cambridge before the



In one of his many roles in the St. Louis area, Harold Thayer, '34, President of Mallinckrodt, Inc., consults with an employee. (Photo: St. Louis Globe Democrat)

Harold Thayer: Meet Mr. St. Louis

To a person with ideas and energy, the world often seems resistant to change. The temptation to change oneself — location, lifestyle, or job — on rare occasions permit one to watch those dreams of progress reach fruition. But Harold Thayer, '34, is one person who did not yield. His dedication to improvement in the St. Louis area was of such consequence to earn him the honor of Man of the Year in 1972 by the St. Louis *Globe-Democrat* for his countless civic activities, and the Chemical Industry Medal last fall for his high achievement at Mallinckrodt, Inc.

When Harold Thayer moved to St. Louis over 35 years ago to work at Mallinckrodt, he had a dim view of his future there. In this family-owned-and-operated business, the ties to tradition were strong and he "was interested in trying to find ways to make things happen faster." He stayed with it and is now Board Chairman and Chief Executive Officer of the company.

The advent of the atomic age had pushed Mallinckrodt out of the field of drug processing. They were chosen to purify the uranium which fueled the first atomic chain reaction in 1942 (Thayer was War Production Board Coordinator for the company), and for the next 25 years they continued to specialize in the processing of nuclear fuels. But the company was unable to compete and during the 1950s profits faltered. It was Thayer's decision to bequeath this field to the giant corporations. At thE same time he diversified Mallinckrodt's chemical products — food, drugs, cosmetics, and industrial specialty chemicals — and sought an expanded international market.

His leadership since he became President of the company in 1960 has spurred record growth and earnings despite the lean years that beset others in industry. Mallinckrodt's net income has leapt from $ 815,000 in 1962 to more than $18 million in 1975. And in 1975, the worst recession in 40 years, their net sales increased 8.3 per cent over the preceding year and earnings per share improved 10.2 per cent.

When he became President, "I got the chance to work on all the things I had been bitching about for 20 years," he recalls. But this new-found influence also made him aware of the responsiblity business owes to the community in which it thrives. Now there's hardly an organization in St. Louis that hasn't found his assistance. Some of his activities have included: President of the United Way of Greater St. Louis, Director of the Council of Boy Scouts, Director of the Arts and Education Council, President of Civic Progress, Inc., and Chairman of their committee on civil rights.

Still Harold Thayer's success is not without frustration. Hence his message to the Chemical Society upon the presentation of their award. He fears that government intervention will provoke the end of the free enterprise system. Government regulation has handicapped business by $130 billion a year in lost productivity, business costs, and artificially inflated prices, he said. Mr. Thayer advocates a moratorium on new goverment legislation — old laws should be re-evaluated on a cost-benefit basis, and the machinery to implement these laws should be established. The appropriation of money for agencies to carry out the task is not enough. Business leaders have their part to play, too. They should identify the costs of regulation and use these figures to oppose its burdensome costs in the future. Companies can take an active role in drafting legislation at hand, and cooperate with employees and unions in their common interests. — *S.F.*

reunion. There are no details yet, but there will be long before the event itself. Dayton has appointed his committee, and it has already had an organization meeting. The Committee: the President will act as Chairman, **George Henning** will be Sports Chairman, **Charlie Cashman** will have charge of the prizes, **Fred Murphy** will acquire the class gift for the attendees (a token souveneir), **George Stoll** will be registrar, and **Stan Walters** will handle publicity. Although not committee members, **Jim Turner**, and **Ellis Littmann**, are included ex Officio, for their long experience in these matters. Again, it appears that long experience will be useful for greeters and marshals, in **Guido Garbarino**, **Roland Glenn**, and **Westy Westaway**. Monthly, we will print further information in these notes.

Dayt also annonces a new appointment: **Cyrus S. Hapgood** as Class Estate Secretary, which seems to mean that **Ellis Littmann** has resigned this one. All of the committee attended the recent meeting but myself, who wasn't informed of a change in location from the faculty club to the student center. So, I decided to sit down with a friend, and enjoy the lobster dinner with a half carafe of good white wine. I had a chap driving for me, so, with a tummy fulla lobster and wine I slept the whole way home. I neglected, above, to say that Dayt told me that he was nominating for the committee, several New York fellows who had never before been involved, so, they are **Guido Garbarino** and **Roland Glenn.**

I have a very short one from **Cal Mohr**, who again reminds me that starting September 1 the Mohrs will be living in Palmyra, Penn. Anyone needing the address, please drop me a line, with the usual family news as part payment for my trouble.

A press release tells us that the National Academy of Sciences will hold a meeting in November at which a number of members will present their personal views of problems of entrepreneurship — one of whom will be our own **Dick Morse**, formerly with the M.I.T. Development Foundation, Inc. . . . Earlier I received one of the finest letters I have ever received at any time, from **Ivan Getting**. I had asked Ivan if Dorothea had passed away, as one of my many sources alleged. So, indeed, Ivan says that she did pass away, after a life-long illness, in spite of which she lived a full life and gave him three wonderful kids. Now, I quote, "Having found happiness with one with whom I could relate, and work with, I decided to remarry, to the widow of my closest friend, Dave Griggs. Dot and I, Helen and Dave, have had many adventures together, and our children know each other quite well. Thus Helen and I got married early this year." Ivan contemplated retiring very soon after August, and since then, has retired from Aerospace. He was its first President, and was so for 17 years. He expressed sorrow in reading aobut Leona's problems, and I hasten to add that Leona is doing quite well; she takes it almost as easy as the M.D. told her to, and she listens to me when and if I offer a word of caution. Many thanks, Ivan, for a very fine letter of good feeling.

We have another impressive note from still another distinguished scientist: **S. Quimby Duntley**. His is in the form of a biography, and interesting it is, and can't be paraphrased much. He stayed at M.I.T. until 1952: six years as a teaching fellow, at which time he got his doctorate degree. Then until 1952, he had two jobs at M.I.T. — teaching in the accelerated war-time program, and with the Optics and Camouflage Division of the National Defense Research Committee. Then with the war-time problem of visibility of the ocean bottom there came the establishment of the Visibility Lab at M.I.T., under the wing of Naval Research. This led to an acquaintance with the Scripps Institution of Oceanography and moved his work to Scripps, a part of the University of California at San Diego. His description of the seaborne and airborne expeditions seems romantic.

Eventually, Quimby turned his time over to graduate teaching at Muir College of the University of California, and is now a Professor Emeritus. Dang it all, Quimby, is ain't easy for a plain

engineer even to copy your story. Fellas, this is sure as all heck an exceptional man.

Quimby's family story is also worth a comment. In 1937 he married Mabel Austin, who then attended the New England Conservatory of Music. She was his date at the Junior Prom of that year. They have a son in San Diego, with General Dynamics; and two daughters, both of whom are married and live in Tucson, Ariz. The Duntleys have five grandsons and one granddaughter. Last, but not least, Quimby says that he has seen **Bill Huston,** and **Ivan Getting** since 1935, and has every intention of attending the 45th, come 1978.

Somewhere late August I had a phone call: "Dr. **Harper** is calling Mr. Henderson from Hattiesburg, Mississippi." I know that he had not been drinking, and, like him, I sure was glad to hear his voice after too many years. But, the story of the **Harper** book, *Anything can cause Anything* is old stuff. Bill's new home is already finished and occupied, and he is very happy with it.

We have a fine letter from **Carl Swanson**. Carl has been retired three and a half years, and, frankly, he would prefer a full-time or part-time job. Maintaining the house and grounds becomes tedious, and tiresome. Many have discovered this, and, many have found out the exact opposite. You may not vote for both sides. Thanks a million, Carl.

Several weeks ago I had a fine, long letter from **Ellis Littmann**, mostly to do with the moving of Company Headquarters, though still in Saint Louis. With the change in location of corporate offices, also comes a change in corporate name — now Nixdorf-Krein Industries, Inc. Gee, I almost gummed that one up. Thanks, Ellis, and, as always, best to Roz. . . . We now have a press release from Aerospace Corporation announcing the election of a new President, assuming the duties of Dr. **Ivan Getting**, who retired at the same time. . . . From the irrepressible **Beau Whitton**, comes an Alumni Fund Capsule, announcing a busy fall. He and Daphne went on a trip to Ohio and Michigan, where they saw several of Beau's cousins, and a bunch of Daphne's kin on the way home. Beau is gradually getting used to the retiring bit, and. . . . being a grandfather comes easy to Beau. . . . Another Capsule is from **Richard (Dick) Molloy**, who is still working for the Longyear Corporation as President. I quote, "With four grandchildren — the product of one son, and one daughter, and three stepsons — we have plenty reason for visiting Gardiner, Maine; Syracuse, N.Y.; Kansas City, Mo.; Denver, Colo.; and Phoenix, Ariz. We managed a trip to Hawaii, also." Now, attention men, front and center. Dick says that he would like to have a few of the old course XVI get in touch with him. Dick, I can't print addresses, but, you tell me who you wish to hear from and you get the addresses pronto. And this brings to mind a larger idea which has occurred to me. I'd like to ask every one of you to give me a short list of those you would like to hear from. That idea can prove to be fruitful, for all of you and also for me, as I will have to claim any news that arises from the conflict. I tried this 10 to 12 years ago, and it was not too noticeable a success. Perhaps, with no reuinon coming up, it might help drag a few more to Cape Cod, come June.

We have but one of ours who has passed to his reward, **Edward D. Rohn**, Course XVI on November 26, 1976. The Alumni Association writes to every one of these cases, regardless. So, I write only if I hear from the family within six months, as it surely becomes an anti-climax. As a supplication, will not all survivors of these passings, drop me a line, EARLY, so that our messages will carry some meaning. An old condolence note only serves to reopen an old wound, usually.

To the fellows and gals of the Class, and all the lovely wives, Leona and I wish to extend our most sincere Christmas Greetings, and for the Best New Year ever. — **Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, N.H. 03833

34

I'm afraid the notes this month are on the skimpy side, primarily because of lack of input. They are being written in Tupper Lake, where we're spending a day on the way to Canada. This may seem odd but it's the only way I can make the deadline — I think for a change I should make one of them.

Our primary reason for going to Canada is to see Mona and **Eric Isbister**, who are now living in Ottawa. As I mentioned earlier, he reached retirement age at Sperry in June, then went to work for Sperry Canada as a consultant on a radar control system for the St. Lawrence River. Hence the move to Ottawa for at least one year. By happy chance, we are able to time the visit so as to see the fall foliage and also take in a small convention of British railway modelers that is being held in Ottawa.

One of the class members, **Frederick W. Baumann**, who received his S.M. in 1934, has been honored by the General Electric Co. That company has made a grant of $5,000 in his name to M.I.T. The award program was originated in 1973 in honor of Charles Steinmetz to provide public recognition for G.E.'s top technical people. Mr. Baumann retired from G.E. in 1977 after serving as engineering manager of the company's Small A.C. Motor Department in Schenectady. He had been with G.E. since 1935, and this Steinmetz Award was received for a series of major electric motor innovations, including the linear induction motor and the aluminum redesign of A.C. motors.

There's only one Alumni Association note this month (I knew I should have held some of the last ones over). It is from **Donald N. Adler** who says, "Retired to Maine in summer and south in the winter. We have two M.I.T. friends in this area — Ernie Steel and Stuart Knapp, both from the class of 1931. Always glad to hear news of alumni, etc."

We had a pleasant visit from **'Stead Wright** who dropped in out of the blue this past summer. He and his wife had come east from Wheaton, Ill., to spend some time on and near the Cape so that he and his wife could do some ancestor hunting. He came to the right place, because my wife, Jane, had helped form the Cape Cod Geneological Society. It was nice to see him and we had a couple of visits. They were making a sweep that was to include looking at possible retirement spots in Arkansas. — **Robert M. Franklin**, Secretary, 620 Satucket Rd. (P.O. Box 1147) Brewster, Mass. 02631; **George Bull**, Assistant Secretary, The Elizabeth, 4601 N. Park Ave., Apt. 711, Chevy Chase, Mass. 20015

35

Francis W. Muldowney, Jr. is the New Class Golf Champion for 1977 after winning his final match from **Frank Hatch** of Burlingame, Calif. Congratulations for a job well done, Fran. He will hold the engraved President's Trophy until the next champion is established next fall. We had a most successful 17th season for our Class Tournament with a record 30 participants. We hope to pick up another group of retirees next season. We also had a record number of matches played head-to-head with a full flight of 16 players in New England and Metropolitan New York City. Fran was winner of the Cardinal Flight and gained the finals by winning from Bill Cross who had won the Grey Consolation Flight. Frank was winner of the Grey Flight and made the finals by beating **Allan Mowatt** by half stroke — he had won the Cardinal Consolation.

Here is a letter I received from **Gerry Rich** in June: "As you probably know I have been teaching at West Valley College in Saratoga and also at San Jose State University. I like it very much and probably should have gone into teaching before. I like the association with the students. I have been playing golf about once a week for a few months — have a neighbor who gets me out. Can't say I have been very consistent — 85 one week and 95 the next. I would really like to play in the (Class) tournament this summer, but Verna and I are going to Europe June 28 for six weeks. Will get a car and drive, visiting Austria, Yugoslavia, Italy, France and Switzerland. I am trying to learn two more languages fast."

It was nice to receive a letter loaded with information from Sue-Jo Moffatt, wife of **Lester H. Moffatt**, 3728 Cresthaven Terr., Ft. Worth, Tex. 76107. "Lester took early retirement about three years ago after he had earned his 35-year service pin as aerospace engineer at General Dynamics. He has written and published the book *Protect Your Retirement Income Against Inflation*. The book is a guide for everyone who is considering retirement, about to retire, or now retired. In computerized charts it shows year by year how to plan secure budgets that will maintain an independent, dignified standard of living for retirement in spite of prolonged inflation. The only investments advocated are government-insured savings and a home." She also wrote about their two children who are making names for themselves in the music world. Katy is coming up with her second Columbia Album — the first was named KATY — and she is located in Denver. Hugh is a singer-writer in Nashville and both have been mentioned in the same issue of *Billboard* several times. Quite an accomplishment. Many thanks for taking the time to write of your family, Sue-Jo. Next time tell us about you, too.

Our Class was represented at the Alumni Officers' Conference by **Rufus Applegarth** Sara and **Nix Dangel**, **Pete Grant**, Doreen and **Allan Mowatt**, and Rhoda and **Bernie Nelson**. Wait until you see the changes that have been made in 10-250. Wonderful.

I am sorry to have to report the deaths of **Arthur S. Hamilton, Jr.** in Rochester, N.Y., on September 23, 1977; **R. Donald Purcell** in Huntington Woods, Mich., March 21, 1977; and **John M. Main** of Tacoma, Wash. on July 11, 1976. Our sympathy and regrets are sent to the surviving members of their familes.

May you and yours have a very happy and festive holdiay season, and please resolve to write at least once to your class secretary in 1978. — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass 02160

36

Elliott Robinson reports that he saw only two classmates at the Alumni Officers' Conference in October. (It was Columbus Day weekend, making attendance impossible for some of us.) **Dick Halloran** was East from San Francisco and **Eli Grossman** and Vivienne also attended.

Class news becomes ever more interesting as one examines the variety of retirement plans: **Norm Bull** retired from Kimberly-Clark in Neenah, Wisc., last March and is looking forward to "an eastern/southeastern swing, not looking for retirement locations but rather enjoying the scenery and seeing some friends." . . . May and **George Moustakis** celebrated with an extended trip this past summer across the country and down the West Coast; they towed a small trailer. George wonders how they ever built the St. Louis Arch. . . . **Norton Miner** is going into politics by running for first selectman of nearby Salisbury, Conn. The incumbent against whom he is running is a lady of the Democratic persuasion. He finds that an architectural background is invaluable for such a contest "in all its ramifications from waterborne sewage to graphics!" By the time you read this the matter will have been settled one way or another. . . . **Rob Wead** (for some years known as Rob Weadd) writes from San Gabriel, Calif., that he returned to college and earned a B.A. in psychology last June. He is now enrolled in a graduate program at La Verne College working toward an M.S. in marriage, family, and child counseling. He is currently doing some supervised counseling with delinquent boys and teaching classes for elderly residents of two retirement hotels. In his spare moments he does a bit of technical work! Rob writes: "When my wife retires from teaching chemistry, we intend to move to Maui, Hawaii, and plug in the counseling and nutrition counseling field there with her psychiatrist son. You can still catch me here for

Clarence R. Horton, Jr., '36, is a tugboat specialist who works as a consulting engineer out of his home in Wilton, Conn. He's most recently achieved notice for the Esso Santa Cruz. (Photo: Thomas Boyd Nash from the *Wilton*, [Conn.] *Bulletin*)

Clarence R. Horton, Jr.: A Rolling Fender for the "Santa Cruz"

Though he lives in Wilton, Conn., 15 miles from Long Island Sound, Clarence R. Horton, Jr., '36, is a man of the sea — the ocean is in his blood, he says. And it's true: since 1965, when he settled in Wilton as a consulting engineer in the marine engineering and shipbuilding field, he's "never had an idle moment," Mr. Horton told Thomas Boyd Nash of the *Wilton Bulletin* early this winter.

His latest achievement is the *Esso Santa Cruz*, a sea-going tug especially designed to help hold an oil tanker on an off-shore open-sea mooring for loading and unloading. Two features make the *Santa Cruz* unique: it's heavy and powerful — 900 tons, 5,600 horsepower — and it incorporates a system of gigantic rubber "rollers" to serve as fenders between tug and tanker.

The nine-and-a-half-foot tire-shaped fenders, attached firmly to the *Santa Cruz,* literally roll up and down the side of a tanker while the tug holds its charge in place. In a recent test at Fort Lauderdale, the *Santa Cruz* rolled 12 feet up and down the side of its tanker without incident.

Mr. Horton learned about tugs at M.I.T. (his major was in naval architecture) and for 16 years thereafter with Dravo Corp. in Pittsburgh. His "proudest achievement," according to Mr. Nash, is his work which persuaded many European operators to change from pull-tug to push-tug barging on European rivers. During World War II he designed landing craft for the British Navy.

another 15 to 18 months."

Kenneth Arnold, who teaches at Michigan State University, is co-author of *Parameter Estimation in Engineering and Science* recently published by Wiley.

It is my sad duty to report the sudden death of **Leonard Cohen** just five months after he made the happy move to the West Coast and started with Hughes Helicopter Co. I have written to Ruth and their son Alex to express our sympathy. — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, Conn. 06091

37

In February in Orlando, Fla., **A. R. Graustein, Charles Chase** and **Mary Thompson** attended the second Florida Festival of all M.I.T. Alumni Clubs. More than 260 attended which included 130 alumni representing 48 classes from 1910 to 1974.

Les Klashman, your assistant class secretary, is still recuperating at home from heart surgery. He has to take it easy for another six or eight months. . . . **Joe Morgan** will retire in December after 36 years at Texas Christian Univ. . . . **Robert B. Stone** of Honolulu has been awarded the first doctorate in psychotronics, the newly recognized energy of conservation. He is the author and co-author of over 50 self-help books. . . . **Bert Bennison** writes that he is now health program supervisor in Tallahassee, watching over 14 county health departments as they react to the crunch in health care in Florida Panhandle. At this writing his four kids, scattered from R.I. to Oregon, are: remedial reading teacher, computernik, ecology freak, and little theater actor.

E.E. Peterson is president of Rolling Mill Engineers, Inc., which does consulting work in metal rolling. He is also president of a company raising feeder cattle. **Robert F. Brown** writes, "I just retired from Martin Marietta Corp., Vanderberg Flight Operations, Vandenberg A.F.B., Calif., after 21 years of varied areospace assignments; preceded by ten years as Associate Professor of Mechanical Engineering, at the U. of Colorado, and eight years of field engineering assignments with Wright Aerospace Corp. My wife and I plan an active retirement as members of a cooperative to develop an attractive ecologically oriented community in Oregon."

David F. Tuttle has written a new book based on some 10 to 15 years of teaching the subject "CIRCUITS" to Stanford juniors. . . . **Duane O. Wood** retired last year as President of the Lockheed Calif. Co., and is now doing consulting work for several European and U.S. concerns on international marketing programs. He still lives in Los Angeles and spends a great deal of time in Europe and the Middle East. . . . **Henry T. Gibbs** is enjoying life at leisure in Laguna Beach, Calif. He retired last year from an active career in the space program for N.A.S.A. Henry would like to hear from anyone visiting his area. . . . **Curt Powell** has been re-elected Chariman, Arizona Council of Engineering and Scientific Associations, and elected a Director of Arizona Industry-Business Education Council.

Syd Karofsky and his wife Syl have just returned from an unusual trip, leaving Boston, then to the Orient, down to Bali, Singapore, Nepal, Hong Kong, Istanbul, Vienna, London and home with some interesting stops in between. He met some M.I.T. alumni in Vienna attending the Young Presidents Club meeting. His son Paul is now president of their wallpaper, paint and decorating firms, and son Peter is an established physician in Wisconsin. Syd has five grandchildren and two great daughters-in-laws. . . . **John A. Down**'s address is now 923-10th St., Douglas, Ariz. 85607. . . . **Harry Kohl** has moved to a new home at 1847 So. Eastview Dr., Camona Island, Wash. 98292. . . . **Harry Goodwin** has just accepted a 15-month assignment in Brazil. — **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Lester Klashman**, Assistant Secretary, 198 Maple St., Malden, Mass., 02148

38

The Alumni Officers' Conference in early October was a huge success as always. The high point was the dedication of the new 10-250 lecture hall. The president of our class and of the Alumni Association as a whole, **Norm Leventhal**, presided. The seats were so comfortable that it's much easier to fall asleep. For a measly $2,000 you can get your name on one. We then had a reception in the partially completed Margaret Compton Alumni Gallery, which will be the gift of our class. The gift is also partially completed. Attending were the usual perennials, President and Muriel Leventhal, Phyll and **Don Severance**, Ina and **Haskell Gordon**, Jean and **Ed Hadley**, Californian **Strauss**, and **Al Wilson**, along with Ruth and **Frank Kemp**, Nancy and **Dave Wadleigh**, and **Paul Desjardins**. A special added attraction was **Bill Whitmore**, who came all the way from the West Coast.

Long before you read this, you will have received two yearbook questionnaires. Approximatedly 12.736 per cent of you will have returned them. Many thanks. The others will have put them aside, waiting until you can get a picture taken, having more important (to you, not to us) things to do, or simply wondering why you should do anything. I know it's a chore but the other members of the class are interested in *You*. If the picture is holding you up, send in the biography so we can format the book — we'll add the picture later. Also, thanks to those who have given us informals — we can still use more — on family, Institute, classmates, reunions. Your friendly editor and assistant class secretary will be grateful for anything. — **Ed Hadley**, Assistant Secretary, R.F.D. 2A, Spofford Rd., Boxford, Mass. 01921

39

Phil Bush, '39

Phil Bush was named group Vice President of Kaiser Engineers, Inc., to be responsible for the operations and business development activities of the advanced technology, transportation, and commercial-medical-institutional divisions.

Phil has been Vice President during the last 14 of his 35 years with Kaiser. Phil and Marjorie have been active over the years in community activities, including sponsoring the San Francisco Symphony. They make their home in Orinda, Calif.

Bob Cotton, Vice President of ITT Continental Baking Co., has returned to ITT World Headquarters after completing an assignment in Chile as director general of Fundacion Chile, a nonprofit foundation to improve food, nutrition and telecommunication sectors of Chile. Bob will welcome mail from classmates at his new address: 13 Pride's Crossing, New Canaan, Conn. 06840.

Oz Steward has written from 3395 Green Meadow Circle, Bethlehem, Penn. 18017: "As the former Class Secretary for '39, I recollect including in one issue of the class notes that a '39er in Connecticut is — or was — curator of a clock museum there. I tried to retrieve his name by going through the Alumni Directory, but to no avail. Would you be able to retrieve that information for me, without too much trouble? One of our daughters is studying at the Yale Graduate School of Design, and a project is a photo essay on period clocks."

It would be fun for our classmates to join in generating a response to Oz. Please write your sugestions directly to him. My suggestion to Oz would be to write to **Gus Hunicke** who is reported to own a company which makes counting devices. Gus and Prilla make their home at Horseshoe Dr., Westbrook, Conn. 06498, phone (203)-399-6155. — **Hal Seykota**, Secretary, 1421 Calle Altura, La Jolla, Calif. 92037

40

Little Noted: **Leo Pach** was the only '40 classmate to send a note of attendance for the reunion on Technology Day this past June. He found the day exciting, but without meeting a classmate. He was able to meet a few of his "former teachers," now 37 years later.

In the Thereafter: We all note the increasingly frequent news of '40 mates' retirement plans, some with gentle schemes for quiet places, others with determined agendas for moveable feasts. The spectrum is at once fascinating and suggestive to the entire class. Share your dreams with us. Contribute at length, please, to our special department, "In the Thereafter."

Missing Person: John Pitkin, '37, kindly sent on a notice from Laguna Niguel, Calif., telling that **John R. Pellam** died in Irvine, Calif., July 23 after a long illness. He had left the Cal Tech faculty for the University of Irvine physics department in 1965. The notice sent is the first we knew of Pellam's death.

M. Bryce Leggett died August 13 this year in Lynnfield, Mass. Alumni who serve on the Educational Council will remember Bryce as the Associate Director of Admissions.

Hey, Mac! This month's roll calls: **Robert D. MacDonald**, Newtown, Conn.; **Donald E. MacHarg**, New York, N.Y.; **Allan W. MacKay**, Hampstead, Quebec; and **Richard E. MacPhaul**, Springfield, Mass. — **Frank A. Yett**, Secretary., 254 S. Euclid Ave. Pasadena, Calif. 91101

41

Odd, but here it is October and I'm wishing you a Merry Christmas.

For the second year the Alumni Fund has passed the $4 million mark. A total of 21,125 donors gave a record $4,851,160. Two hundred eleven of our Class, or 46 per cent gave a total of $183,173. Only nine other classes (1905, 1909, 1921, 1922, 1923, 1927, 1948, 1952, 1955) exceeded our total. Congratulations to our Class Agent **Robert Demartini** and our Class Estate Secretary **Howie Samuels.**

Irving Foote writes that he has returned from his sixth trip to Rio and Sao Paulo, Brazil. He is Vice President for Manufacturing and Engineering for Glidden's Coatings and Resins Division. . . . The National Academy of Engineering had **Ralph Landau** as a keynote speaker on entrepreneurship. Ralph is qualified to talk on that subject — and more. . . . **Howie Samuels** was in the news again as the Finance Chariman of the N.Y.C. mayoralty candidate Mario Cumo.

Joe Gavin was featured in *Business Week*: — "Grumman's Gavin has ordered energy research directors to report directly to him. 'I review everything — I'm our No. 1 energy enthusiast,' he says. Gavin, who plans to form a new energy subsidiary to coordinate Grumman's energy projects, has picked a mix of new energy-product areas that he thinks will permit relatively quick, as well as long-term, payoff. Grumman's first major energy line, solar hot water heaters for home use, hit the market in January with heavy advertising. But it will be a decade or more before Grumman research into orbital power stations, fusion reactors, and windmills can pay major dividends."

Keep on sending in what's happening in your world. — **Henry Avery**, Secretary, U.S.S. Chemicals, 2863 — 600 Grant St., Pittsburgh, Penn. 10605

42

George Granitsas has been appointed manager of American Optical Co.'s Pilot Facilities Development Department at Sturbridge, Mass. George is no narrow-gauge fellow; he is past President of the Greek Orthodox community of Marlboro, member of the Marlboro Industrial Board, trustee of the Marlboro Savings Bank, and member of the Sturbridge Finance Committee. . . . **Roland Danielson**, who has been with Bethlehem Steel Corp. ever since graduating with our Class, has been promoted to Manager of Ship Development and Sales for the Corporation. He will be responsible for all new ship design development and marketing.

By the time we all have these notes, it will be about two months too late, but **Jack Sheetz** is teaching a course (in September and October) as part of the Tufts Alumni Council Continuing Education Program. Just couldn't resist its very intriguing title: "Shake Hands with your Friendly Computer." Maybe Jack will do a short rerun for us at our next reunion.

Our president, **George Schwartz**, **Lou Rosenblum**, and I had a very good planning meeting with Jim Champy, Dick Knight, and members of the Alumni Association staff on September 26. This was followed by a sort of "ad hoc" caucus, or what-have-you, of all the 1942ers at the Alumni Officers' Conference: Carole and **George Schwartz**, Mariejeanne and **Al Dengler**, Angelika and **Bob Howard**, Dottie and **Floyd Lyon**, Mary and **Ed Vetter**, **Lou Rosenblum**, **Mort Goulder**, **Jim Littwitz**, and Jean and I. You can see it was a pretty good cross-section of the Class. We discussed several plans for our next five-year activities, and you'll surely have the letter from George on them before you see these notes!

Thought that I'd introduce our officers a few at a time in each issue. (Matter of fact, I didn't think it up, either; George suggested that since we have a lot of officers, and that all our classmates might not know them, some capsule bios might be useful.) So we'll start this time with the first three.

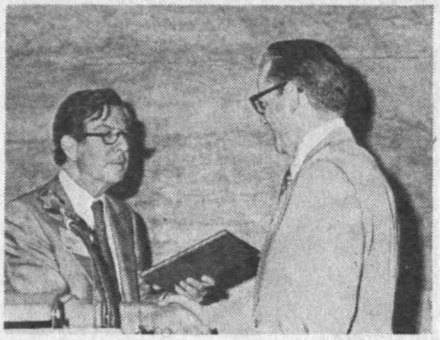
George Schwartz, our new President, and his wife, Carole, live in West Newton, Mass., and have two daughters, Nancy Ellen and Patricia Ann. George lists his hobby as golf, though Carole beats him at it! I think his real hobby is M.I.T. alumni activities. He chaired the A.O.C. Committee year-before-last, is now serving on the Technology Day Committee and is a past Director of the Alumni Association. He graduated from Course VI and has impressive and varied experience in servomechanisms, instrumentation, shoe machinery, electronics, and sundry other technical areas. He now does consulting for investment and acquisition in high-technology business ventures.

Our Executive Vice President is **Charlie Speas**, also Technical Vice President of Hedwin Corp. in Baltimore. He and Betty have three daughters, and when he is not busy designing and manufacturing plastic containers and machinery for Hedwin or traveling (which is their current hobby) Charlie does just about everything that has to be done in the world of M.I.T. in the Baltimore area.

Marty Levene, our ever-so-prudent Treasurer, and his wife Irma live in Brookline. They have a son and two daughters, all out of college, and, I think, out of the family nest. Marty is a recognized authority on radiotherapy dealing with the treatment of cancer. He is assocaited with several of the hospitals and universities around Boston; and if that is not impressive enough, he lists his hobbies as amateur cinematography, electronics, sports cars, woodworking, and striped bass fishing!

During the last summer, Betty and **Charlie Speas** spent a month driving about 1,600 miles around Scotland. Their base of operations was an old farmhouse near Inverness which was just 30 miles from the Loch Ness "Monster" Expedition at Drumnadrochit, so they visited with **Bob Rines** there. They had a personally guided tour of the whole lay-out, including underwater sonar detection and "triggering" equipment plus the stroboscopic photographic gear.

Bronze Beavers were awarded to: Norman R. Klivans, '40, (top, at right): "For energetic, positive and sucessful leadership of M.I.T. Alumni Fund and Club activities. Norm's outstanding service on behalf of M.I.T. provides a constant source of pride and inspiration to fellow alumni in the greater Cleveland area," and Alfred C. Wu, '40, (bottom, at left): "Al has served the Association and M.I.T. with many years of unselfish service: Educational Counselor, Club Officer, Advisor and Board Member, Organizer and Patron of countless events, Fundraiser, and Arts Council Member. A quiet, warm friend of many; an effective and energetic worker; and one who, by his own example, has set an ideal for each of us." (Photos: Roger Goldstein)



Alumni Association President Norman Leventhal, '38, (left), awards the 1977 Bronze Beaver to Edward O. Vetter, '42, (above right): "Ed has served M.I.T. and the Association in countless ways: as Alumni Association President, Co-Chairman of the M.I.T. Leadership Campaign, Alumni Fund Board Chairman, Corporation member, as President of the M.I.T. Club of Dallas, and in countless other local and national positions. He has served his country as Under Secretary of Commerce with distinction and brought further national prominence to M.I.T. His role of volunteer leadership is a true example of unselfish dedication to M.I.T., a record equaled by few but to be held as an example to many. As a thoughtful leader of the Association he has brought renewed enthusiasm to the efforts of our alumni."

And to Floyd A. Lyon, '42, (below right): "Devoted humanitarian, willing and energetic volunteer of long standing. Floyd serves as Estate Secretary for the Class of 1942, a Director of the Alumni Center of New York, a member of the Corporation Development Committee and Co-Chairman of the M.I.T. Leadership Campaign for Long Island. We honor him as being among that small body of dedicated alumni on whom we most often depend for continuing leadership and service to the Institute."
(Photos: Calvin Campbell)

Charlie Speas, '42, (right) and Bob Rines, '42, out on the Loch during the July, 1977, Loch Ness Expedition in Drumnadrochit, Scotland.

Last but not least (but we've got to end these notes somewhere), our Class was honored at the 1977 A.O.C. by what is probably the biggest single year's haul of Bronze Beavers ever presented at an Awards Luncheon. They went to **Ed Vetter**, **Floyd Lyon**, **Jim Littwitz** and to your secretary. I can report for all of us: we were pleased, proud, and thrilled. If my records are correct, the Class now has a total of eight Bronze Beavers. That, too, could be a record!

Very best wishes for a happy holdiay season and a healthy, prosperous New Year. — **Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, N.Y.10605

43

News of retirements dominates. **Robert L. Townsend** retired last year as Chairman of Grumman International, and is now a consultant. He had previously retired as a Vice Admiral, U.S.N., after being the Commander of the Naval Air Systems Command in Washington, D.C. . . . **Robert K. Dix**, who received his doctorate with our class, retired from Exxon Chemical Corp. after 34 years of service, most recently as senior vice president and a member of the management committee.

The credit for the remainder of these notes goes to former class president, **Jim Hoey, Jr.**, who called me with the following. On October 12 he received a call from **"Tony" DelValle**, collect, from New York City, who reported that he had just returned from a six-week vacation in Europe with his charming wife, Carmen. He will be in Boston in December, he told Jim. Then on October 13 Dr. **Frank Swenson** called Jim, collect, from Chippawa Falls, Wisc., to report that he had retired from his position as chief of radiology at the Akron, Ohio, City Hospital, and was working, on call, for the State of Wisconsin. The following day, October 14, Jim drove to Montreal on business, and had cocktails with **Fred Kaneb**, who described his various businesses such as plastics, fuel oil, and a Cott's soda distributorship for the State of Florida, no less. Fred reported that his wife, Mayford, has recovered well from serious surgery last year. He allegedly cried the blues about the 90 cent Canadian dollar, so guess who picked up the check for that soiree? Margot and I will be at our Palm Springs residence in December, so call us there. — **Richard M. Feingold**, Secretary, 779 Prospect Ave., West Hartford, Conn. 06105

44

Among the many benefits to M.I.T. alumni living in the Boston area is the M.I.T. Club of Boston and its activities. Recently we joined the Club for a cruise of the Boston harbor on the *M.S. Bay State.* The full moon added an exclamation point to the beautifully clear summer's evening. We met classmates and schoolmates. **Joe Donahue**, looking like Hollywood Central Casting's idea of a dentist — which of course he has been for the last decade — was there with his wife, Miriam (who is doubly linked to '44; she's **Larry Varnerin**'s sister). Their daughter Martha, also an M.I.T. graduate, and her friend from Berkeley were with them. **Leslie Brindis** and his wife Anita, from Haverhill, were also there to represent '44. We bumped into a schoolmate, Edward Payne, and his wife Margaret. He's Class of '17 and continues in a full, active, and life-affirming style. Following his retirement at age 65 from Bell Labs, he spent 15 years working in Washington for the U.S. government. At 84 he's chomping at the bit looking for a new career.

A note from **Alan S. Michaels** says that he resigned in August from ALZA Corp. of Palo Alto, Calif., to accept an appointment as Adjunct Professor of Chemical Engineering and Medicine at Stanford University, where he conducts biomedical engineering research, with major emphasis on nephrology and the artifical kidney. In November of this year he received the 1977 Food, Pharmaceutical and Bioengineering Award of the American Institute of Chemical Engineers.

Bob Clarke sends a clipping announcing the engagement of his son Bruce (Rutgers '77 and now a graduate student there) and Ellen Vernachio (Douglass '76). We spent October 7 and 8, at the Institute attending the Alumni Officers Conference. The presentation of the new Huntington Hall (a completely redone and refurbished 10-250) to the Institute and the dedication of the Alumni Center on the first floor of the Maclaurin Building and the Margaret Hutchinson Compton Gallery highlighted the activities. The location of the Alumni Center (opposite the lobby which opens directly onto Killian Court and adjacent to the Alumni Courtyard which is surrounded by the MacLaurin and Vannevar Bush Buildings) serves as a constant reminder to the students of alumni interest in them and in the Institute. The Alumni Center will provide a permanent area for many alumni activities. Our thanks go to **John G. Barmby**, **Robert E. Benedict**, **Andrew F. Corry**, **William W. Henderson, Jr.**, **Richard H. Hinchcliff**, **Alexander Kusko**, **Lorenzo A. Lamadrid**, **Edwin G. Roos**, **Joseph J. Snyder**, **John R. Taft**, **William T. van Ravenswaay**, and **Lawrence J. Varnerin, Jr.** for their contributions to this project. Special thanks to **Edwin G. Roos** and **Joseph J. Snyder** as donors of Huntington Hall Named Chairs. (The Alumni Association is still accepting donations for this project and chairs are still available for purchase.)

We saw **Andrew F. Corry**, **Jack H. Frailey**, **John L. Hull** and his wife "Buz," and **John R. Taft** at the conference. We missed **Jacquelyn M. Findlay**, **Alexander Kusko**, and **Stanley W. Warshaw** who were also among the registered guests.

Next month we plan to share with you parts of a letter from **Art Peterson, Jr.** His thoughts may help those of you who may be considering a career change.

Our greetings for the holiday season and best wishes for the coming year. — **Melissa** and **Newton Teixeira**, Secretaries, 92 Webster Park, West Newton, Mass. 02165

45

Merry Christmas — and to think that my last greeting was Happy Easter! Where-o-where did the little year go? Seriously, your secretary has been remiss, as have you, for I need news items from you if these notes are to be meaningful. End of lecture!

President **Bob Magiathlin** advises that there is a Greater Boston group that is again considering a mini off-year reunion. You will recall that several went to Spain in 1973 as well as Bermuda in 1968. Where — and who — in 1978? As the Class President's letter indicated, we are anxious to have your thoughts as to both interest and location. Rest assured these off-year affairs are great fun.

Fortunately — or unfortunately, as the case may be — international travel has become my bag! Two weeks ago I returned from 16 days in Australia/New Zealand and these notes are being penned as Frannie and I wing it to Europe for a three-week business trip (business for me and vacation for her). Last spring I became Regional Field Manager — International at Allendale, which has me in Europe about four times a year plus assorted other trips in and about the world. While still on the Springers, we should mention that Lou and **Pete Hickey** joined us "Down Maine" for four or five days of delightful cruising on our Tartan 27 in early August. It is amazing how one can relax with old friends despite the fact that we had not been together literally for 20+ years.

Speaking of Maine cruising, Louise and **Tom McNamara** spent some time in mid-July in the Wells area with Elaine and **Bill Shuman** aboard the latter's Crooker sloop. Last spring the McNamaras had a great trip to Australia, India, Nepal and Japan. After ten days as the chief U.S. delegate to an International Standards Organization meeting in Sydney, it was off to Calcutta and Nepal before work in Japan for Mother Honeywell. In Calcutta, Tom and Louise were entertained by Amatam Baggchi, '72, who incidentally had been "hosted" by the McNamaras while at the Institute. While in the Napalase National Park a Buddhist monk asked Tom, "Is that a Brass Rat you're wearing?! I am George Churinoff, Class of '67!"

Don J. Lovell continues an active professional life at the University of Massachusetts, with great activity on the technical council of the S.P.I.E. as well as councillor work for the local section of the Optical Society of America. . . . **Ed Malloy** remains most active in civic activities in Cheraw, S.C.: President of Pee Dee Council, B.S.A. in '75, '76; President — Kiwanis '76; Commander, American Legion, S.C. '76, '77. . . . **Thomas S. King**, RADM U.S.N. (retired), is now General Manager of the Oregon Regional Public Transit System. . . . **Miles A. Libbey** was appointed Assistant Professor, School of Library Service, Columbia University, in July, 1977. . . . **Isaac Goodbar** continues in the computer industry. . . . **Dick Battin** of the Draper Lab presented a paper entitled "The Epoch State Navigation Filter" at the September A.I.A.A. meetings in Grand Teton, Wyoming. . . . **David O. Richards** continues to be with Owens Corning; presently Director of Research and Developement Services at the OCF Technical Center, Granville, Ohio.

Active in the successful 1977 Alumni Fund drive were **Chris Boland**, Class Agent; **Spence Standish** and **Jim Hoaglund**, Special Gift Chairmen in Schenectady and Twin Cities, plus **Al Cohen** and **Curt Beck**, Chairmen in New Rochelle and Amarillo, Texas. It seems that Curt Beck of Pampa, Texas, has been an area chairman forever!

Last April **Bob Welch** of West End Brewing Co. in Utica, N.Y., wrote, in part, the following: "Still with West End and still living in Barneveld, 15 miles north of Utica. Now Vice President for Finance and Corporate Development with efforts directed towards corporate investments including two subsidiaries in Vermont — Harrington's of Richmond, a producer of smoked ham, turkey, bacon, etc., and The Enchanted Doll House in Manchester Center." Carol and Bob have not been traveling as they have had three in college: Mike, a Colgate graduate now in medical school at the University of Rochester; Chris, a senior at Williams; and Susie, a senior at Smith. Molly should be a freshman now and Jana is only a few years off! In closing, Bob advised that the only person he has heard from is **John Gaffney** at I.B.M. in Oswego.

If I am reading my hen scratching correctly, the following couples enjoyed dinner at the Colonade and Pops last Alumni Day: **McNamara**, **Shuman**, **Gallagher**, **Pickel**, **Hart**, **Magiathlin**, **Quinnan** and **Chuck Patterson.**

Last spring **Don Kuehl** and others formed Composite Technology, Inc., in Broad Brook, Conn., to manufacture boron filament. Prior to joining this new firm as President, Don worked for United Technologies' Hamilton Standard from 1955 to date in various engineering and research areas. Much to my surprise, boron has several sporting applications such as tennis raquets and golf shafts. The oldest Kuehl sibling daughter, Allison, a Clarkson graduate, is a Lieutenant in the Engineering Corps at Fort Bragg; next daughter, Claudia, graduated from University of Connecticut last June, whereas son, Wayne, is a sophomore at Carnegie Mellon in Pittsburgh.

A New Year's Resolution — You write and I will report. Have a Happy! — **C. H. Springer**, Secretary, P.O. Box 288, New Castle, N.H. 03854

47

Well deserved kudos were tossed in **Claude Brenner**'s direction for his remarkable job as Chairman of the Alumni Officers' Conference Committee, which culminated in two days of unusually worthwhile activity October 8-9. (Have you noticed how Claude spends hundreds of hours on some project every issue just to get his name in the notes?)

With the Alumni Officers' Conference and the dedication of the newly redone (but still recognizable) room 10-250 comes news of The Seventh Row. This is the row of chairs reserved in 10-250 for the class of '47. Old occupants **Tom McEvoy**, **Claude Brenner**, **Don vanGreenby**, **Jack Rizika**, and **Harl Aldrich** have been joined by **John Karmazin**, **Arnold Varner**, **Bill McCurdy**, **Tom Bell**, and **Dick Knight**, but there's still room for you. Remember, your pledge for a chair can be made over a period of five years, at $400 per year — which, considering the tax bite these days, does bring it to a more manageable size. I believe a five-year pledge also removes your name from the Fund mailing lists for a while, too, which should cut down your mail and their postage bills. And I'm working on some "Reserved" signs for the next alumni event there.

I cornered **Ed Kane** at the A.O.C. and extracted an up-date from him: "I am presently Director of Planning and Business Development for the Power Systems Group, Combustion Engineering, and living in West Hartford, Conn. I was involved as program manager of an international desalinization-power generation program. At present I am responsible for acquistitions and both strategic and operations planning for a division which manufactures fossil and nuclear steam generating plants." Son Jim is a first-year law student at Albany Law School and daughter Patti is a sophomore at Smith College. Wife Jackie is in the Hartford School system as assistant director of a voluntary busing program. Ed is director of the Greater Hartford Unit of the American Cancer Society, teaches Sunday school, and has a 13 handicap in golf. Jackie and Ed are Advanced Level square dancers.

Arnold Judson also yielded to persuasion at the conference to give us some news: Arnold and his three partners (including Daniel Gray, M.I.T. '58, and Peter Gerstberger, M.I.T. '65) have just celebrated the first anniversary of their management and organization consulting firm, the Berwick Group. Based in Boston, Arnold and his colleagues have been working with business organizations throughout the U.S. and in Europe, principally in the areas of strategic planning for individual business and multi-business corporations and of improving productivity and quality of working life. They emphasize strategies that

The 1977 Bronze Beaver is awarded to L. Kenneth Rosett, '42 (above left): "Governor of the New York Alumni Center, Class Secretary, Chairman of the Westchester County Educational Council, active solicitor for the Alumni Fund. Most of all, we appreciate and recognize that as advisor, counselor, and friend over many years, Ken's personal service has been both valuable and unique to the Association and M.I.T."

To James K. Littwitz, '42 (bottom): "For over one quarter of a century, Jim has worked effectively for M.I.T. in strengthening and improving Club, Fund and Educational Council activities. His thoughtful leadership on both local and national levels has helped guide the Association in many of its programs." (Photos: Roger Goldstein)

The 1977 Bronze Beaver is awarded to Christian J. Matthew, '43 (above right): "Chris' quarter century of service in every aspect of alumni activity has made him a leader to whom many, in both San Francisco and Cambridge, turn to for advice. We look heavily to his continued counsel." (Photo: Roger Goldstein)

Alumni Association President Norman Leventhal, '38 (at left) awards a 1977 Bronze Beaver to Kenneth S. Brock, '48 (above right): "Ken's enthusiasm and energy have heightened the awareness of thousands of alumni and deepened the sense of union in a common cause. He shares the distinction, with few others, of being an architect of the Alumni Fund. M.I.T. has benefited immeasurably through his service. His continuing dedication is an example to all." (Photo: Roger Goldstein)

Also, a Bronze Beaver goes to Peter C. Hand, '48 (below right): "Pete's unflagging support of M.I.T.'s efforts in the Orlando, Florida area has been characterized by a professionalism which reflects credit upon the Institute. As an Alumni Leader in Florida, he directed the First M.I.T. Florida Festival held in 1968 and more recently the Second M.I.T. Florida Festival in 1977. His energy and thoughtfulness has maintained the M.I.T. presence in the South." (Photo: Calvin Campbell)

depend on union (or employee) and management collaboration. Increasingly, over the past several years, Arnold has been developing an international reputation as one of the leading thinkers and practitioners in the field of productivity and quality of working life. His article on this subject published in the August, 1976 *Technology Review* attests to this and has attracted wide attention.

Unfortunately I did not have my pen and pad at the ready when I saw **Clif Corbett**, **John Karmazin**, **Arnold Varner**, **Harl Aldrich**, **Mary Frances (Penney) Wagley**, **Jim vanMeter**, **Don vanGreenby**, **Bob Danner** and **Bob Hagopian** but several have promised to write something for us. **Dick Knight**, Secretary of the Alumni Association, was present, of course. **Parker Symmes** and Midge even came back from Bermuda for the conference, but **Jack Rizika**, a bit farther away in England, did not get there.

Dick Knight writes: "Joan and I spent eight days in Peru in August, mostly on the Alti Plano some two and one half miles above sea level. While visiting an Indian village on a floating island on Lake Titicaca we ran into the mother of an M.I.T. student, Senora Montauban. She was supervising a group of students from a private school in Lima who were on a winter vacation tour. Her son Pierre is Class of 1980 and we have promised to look him up when he returns this fall. What a small world and what an international institution we are associated with."

Vera writes to us about **John Barrett** who died in April: "Thank you for your very kind note and sympathy. His death was very sudden and unexpected. He was feeling fine when he left for work but suffered his first and fatal heart attack on his way to the office in Boston. It was a terrible shock to us all as he was always very active and enjoyed life and was looking forward to his retirement." At the time of his death, John was Assistant Vice President for Buildings and Real Estate at the New England Telephone Co., which he joined right after graduation in 1947. Over the years he held jobs of increasing responsibility in engineering, personnel, and public relations. He served on a number of boards, including the Western Advisory Board of Directors of Family Counseling and Guidance Centers, the Board of Trustees of the Regional Y.M.C.A. in Framingham, the Executive Board of Directors of the Framingham Chapter of the American Red Cross, and the Executive Board of the Northeast Region Red Cross Blood Program, of which he was Vice Chairman one year. He was a past President of both the Wellesley Knights of Columbus and the South Middlesex Area Chamber of Commerce. He leaves his wife, Vera (the former Veronica Malley), five children, and four grandchildren. Vera's address is 23 Gordon Rd., Needham, Mass. 02192.

George Russell, Vice Chancellor for Research and Dean of the Graduate College at the University of Illinois, has been named Chancellor of the University of Missouri's Kansas City campus. George served in the U.S. Navy until he retired in 1960 with the rank of Commander. Since 1972 he has been one of four Vice Chancellors at the University of Illinois' Urbana-Champaign campus. He joined the faculty there in 1962 as an associate professor of physics after teaching at Southern Illinois University at Carbondale for two years. At U.I. he was Associate Director, then Director of the Materials Research Laboratory in the College of the Physics Department before becoming Associate Dean of the Graduate College. He and Ruth have four children, ages 15 to 28.

Ginny Grammer (I have to say it that way to get my name in bold print) finished a master's degree program at M.I.T. last June in an interdisciplinary course divided between the School of Science and the Division for Study and Research in Education (Course XXV). My work was in LOGO, (described by Henry Lieberman and Ken Kahn in the context of computer animation in their article in the October/November *Review*. Briefly, LOGO is a procedural computer language which allows one to build increasingly complex things by extensions from a very simple beginning. It is simple enough for fifth-grade children to use easily, yet quite powerful — a cognitively significant way of working which parallels our way of learning. One aim of the LOGO project is to give to children in the schools the ability to make truly powerful use of the computers they will most certainly all have very soon now.

I guess it is reasonably obvious that I no longer live in my house on the cliff overlooking the stream in rural upstate New York. I am in the process of renovating an old townhouse on Bunker Hill in Charlestown, combining the third floor apartment and the attic into one unit. And yes, my architect friends notwithstanding, I may just put that Federal fanlight over my new Mediterranean door! God bless you all! — **Virginia Grammer**, Secretary, 62 Sullivan St., Charlestown, Mass. 02129

48

George Clifford has had two meetings of the committee to plan our 30th Reunion. He has appointed **Sonny Monosson** to Publicity, **Don Noble** to Program, **Leon LaFreniere** to Food/Libation, and **Graham Sterling** to Finance. **Venty Smith** is planning a telethon in November to help with the alumni fund and reunion announcements. Also attending one or both planning meetings were **Bob Devine**, **Bill Katz**, **Harry Ottobrini**, and "yours truly."

The committee considered several options and has decided to begin the reunion program with a cocktail party on Thursday, June 8, 1978. Following the cocktail party on campus at M.I.T., buses will take us to Symphony Hall to see Arthur Fiedler conduct the Boston Pops.

On Friday, The Technology Day Committee of the Alumni Association is planning an all-day program to be presented by the faculty. In the morning, the subject will be on computers in society and then in the afternoon, demonstrations of computer hardware's fascinating capabilities. Friday's lunch will be in Rockwell Cage with the entire alumni body and guests.

By 9 pm on Friday, the class of '48 will have moved to the lovely Chatham Bars Inn on Cape Cod. Chatham Bars Inn is a complete resort with dining, swimming, golfing, tennis, and other recreational activities. Saturday and Sunday will be fun days at Chatham Bars Inn punctuated by class luncheon, cocktails, dinner, and dancing activities. Beginning on June 8 and continuing to June 12, the class of '48 is planning a relaxing and enjoyable 30th Reunion.

Mike Kami authored an article for the June 1977 issue of the American Management Association's magazine, *AMA Forum*. The title of the article is "The Indexed Balance Sheet: A New Focus of Management." Mike writes that management should recalculate balance sheet accounts to show the present value of quick assets, actual replacement costs for inventories, realistic estimates of the cost of replacement of the entire productive capacity; also, costs of long-term debt should reflect effects of inflation, and land and natural resources should be at current market value. "A careful look at the revised balance sheet will reveal many new facts about a company's financial structure, facts that may not be apparent in the traditionally calculated balance sheet." As usual, Mike has reminded us of a valuable technique to effectively manage our companies.

George Clifford, chairman of our 30th Reunion, sold his business to Corning Glass on April 11, 1975. George had operated Clifford Instruments, manufacturer of densitometers and related instruments to measure protein concentration. After George sold his business, he served as a consultant to Corning to help with the transition. Currently, George is on the staff of Corning as Vice President for the Medical Division. George is responsible for acquisitions and product development. One area under consideration concerns a method to measure proteins associated with different forms of cholesterol. George is living in Framingham with his son who is a student at M.I.T.

Ben Ball was appointed adjunct professor of management and engineering at M.I.T. in a joint announcement by Dean William Pounds of the

Sloan School and Dean Alfred Keil of the School of Engineering. Ben is vice president for planning and research at Gulf Oil Corporation in Pittsburgh. In addition to his duties at Gulf, Ben will continue the research and teaching he began last year when he became a visiting professor at M.I.T.

Sonny Monosson was the subject of a *Forbes* magazine article last March. The article said the new value of the used computers that American Used Computer Corp. sold in 1976 was $100 million. Sonny's business handled more units than any of the other 270 independent used computer dealers. Sonny recalled the risks and the breaks. In 1969 he bought a Honeywell 800 for $3,000 (original cost $4 million). It cost him $2,000 to ship it to his warehouse on Commonwealth Ave. Three years later, it cost $1,000 to get a scrap dealer to haul it away. On the other hand, an archaic Univac set cost $1,152 plus $3,000 in transportation charges. Within a year, Sonny sold one-tenth of it for $8,500 and later another part sold for $6,500.

Jack Winninghauf is fabricating welded aluminum boats in Magnolia, Mass. One 30-foot model was sold to the harbor pilots in San Juan, Puerto Rico. The designs use a cathedral hull and are constructed for rugged use. Jack had worked for Perkins-Elmer and Itek in earlier years.

Dot **Farrow** wrote because **John** would never mention his success with a solar heated hot water system for their motel at Dewey Beach, N. J. The solar collectors are on the roof of the motel, and the system cuts down considerably on heating costs in late afternoon when everybody comes back from the beach for showers. John is working on a windmill (savorius rotor type) to run a heat pump for some of their other energy needs. Perhaps Dot's letter will prompt more wives to write and tell us of their husband's activities.

The *Boston Globe* recently wrote a feature on Teradyne, Inc. **Nick DeWolf** and Ales d'Arbeloff, '49, founded the company in 1960. Today, Teradyne employs 1,400 people and makes annual sales now reaching $60 million. Nick is no longer active in the company but serves on Teradyne's board. Several years ago, Nick explained their success as follows, "Figure out what the customer needs. Don't listen to what the customer demands."

Teradyne has sales and service centers at six overseas locations. Teradyne's products basically include computer-controlled test systems for integrated circuits used in computers, calculators, digital watches, television receivers, and radar ovens.

The class of '48 was well represented at the 1977 Alumni Officers' Conference. I managed to chat with Gwen and **Lou Kreek**, Rose and **Leon LaFreniere**, Ann and **Ken Brock**, **Sue Call** and **Bob Bliss**, Gloria and **Sonny Monosson**, **George Clifford**, **Graham Sterling**, **Em Callahan**, and **John Walch**. We welcome Ken Brock as a "volunteer" at alumni activities. — **S. Martin Billett**, Secretary, 16 Greenwood Ave., Barrington, R.I.

49

No news this month from classmates. Very strange. However, if my life is any indication, no news means good news. On my birthday, October 21, our daughter Corky produced our first grandchild, Holly Elizabeth Klimczak, at nine pounds and three ounces. Mother and daughter are doing fine; the grandparents are doing as well as can be expected.

Merry Christmas to all of you. May your new year be a happy and prosperous one, full of joy and excitement and love. — **Frank T. Hulswit**, Secretary, 77 Temple Rd., Concord, Mass. 01742

50

Jon L. Ganger has been appointed senior vice president-senior property manager of Frank B. Hall and Co. of Massachusetts, Inc., New England Regional Headquarters of Frank B. Hall and Co., Inc., international insurance brokers. Jon will be responsible for the production, marketing and coordinating of property insurance programs for clients of the Boston, Providence and Hartford offices. . . . **Joseph B. Oppenheim** is taking a course in Physical Science at Brevard Community College in Melbourne, Fla. Joe also tells us he took a five-day cruise to the Bahamas in August.

Etto E. Von Zastrow has been named manager of the solid state power control branch at the General Electric Research and Development Center. He will direct the activities of nearly 20 scientists and engineers engaged in studies of high power electronics, environmental electromagnetics, and system simulation and control. Etto began his General Electric career in 1951, working as an engineer for various company components at the Schenectady, Waynesboro, Syracuse, and Auburn plants. He is the author of numerous technical papers and co-author of a book on semiconductor applications. He is a registered professional engineer in New York State and a member of the Institute of Electrical and Electronics Engineers. Mr. and Mrs. Von Zastrow and their five children live in Niskayuna, N.Y.

It is with sadness that we report the deaths of **J. Michael Carney** and **Warren M. Cheek**. Mike Carney was head, engineering service and technical editor in the American Plywood Association's Technical Services Division. He joined the Plywood Association as an engineering writer in 1958, and was the author of 16 technical papers relating to engineering and plywood design. He was a Past President of the Southwest Chapter, Structural Engineers Association of Washington. His survivors include his wife, Susan, and son, Bruce. **Warren Cheek** was a vice president with the Florida National Banks of Florida, Inc., and was the director of their investment advisory division. Prior to moving to Jacksonville, he lived in the New York area where, for a number of years, he was associated with Merrill, Lynch, Pierce, Fenner and Smith, Inc. His survivors include his wife, a son and two daughters. — **John T. McKenna, Jr.**, Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

53

Hopefully, all of you received **Bill Spring**'s letter which outlined some of the details for our forthcoming 25th reunion. Please sign up and send in your dues. Recent conversations with **Merrill Ebner** (still a Professor at Boston University), **Al Danzberger** (a consultant with Marcom, Inc., and just remarried), and **Mandy Manderson** (who has taken his consulting business to sunny Florida) indicate that all three will be in attendance. (Mandy dropped by Pittsburgh recently — enroute to give a seminar at Penn State — and we had dinner and a chance to catch up on our affairs, so to speak, for the past nine years.) Also, **Fred Brecher** gave me a call recently while he was delivering his daughter to the University of Pittsburgh to begin her freshman year.

Wonder of wonders, it appears that my eldest son is hardly a "chip off the ole block"; a week after enrolling as a freshman at the University of Colorado he wrote that he was studying very hard and had changed roommates because the first one was "partying until all hours of the night." (Sigh!)

John Rutigliano has come to his senses, left New York, and moved to San Francisco. Currently, he is Vice President with Donald Bentley and Associates in that lovely town. . . . Bethlehem Steel reports that **John Becker** has been promoted to Project Manager (Light Flat Rolled Products, Management Information Systems) in the Steel Operations Department. John has worked for Bethlehem since graduation, except for a twoyear tour with the Army Corps of Engineers; he will be moving to the home office shortly. . . . **Fred Brecher** was a recipient of a Fifth Award in a national competition for the design of welded structures sponsored by the James F. Lincoln Arc Welding Foundation of Cleveland; the award was for the design of a welded truss to span a 500-seat auditorium.

That's all. Please write. — **Martin Wohl**, Secretary, 7520 Carriage Ln., Pittsburgh, Penn. 15221

Bronze Beavers were awarded to Charles K. Holmes, Jr., '49 (above right): "An outstanding alumni leader in many communities, including San Francisco, Dallas, Atlanta, and Concord, Mass. Chuck has served the Association by bringing his enthusiasm and vision to the planning and implementation of many programs on the local and national level."

And to Frederich G. Lehmann, '51 (below): "First as volunteer and then for 19 years as a member of the staff, Fred served the Association unstintingly. He provided a sense of unity and common purpose to thousands of alumni around the world. It might also be said the Fred knows more M.I.T. alumni than any other person. All who know Fred respect him and admire him for his dedication to M.I.T." (Photos: Roger Goldstein)

54

As the year draws to a close we report a busy year for **Fred West**. Last January, he was appointed Assistant Professor of Astronomy in the Physics-Earth Science Department at Central Connecticut State College. He teaches astronomy, supervises a Spitz Model 512 planetarium and supervises and works with a 16-inch telescope. He is continuing his spectroscopic studies of double, multiple and nearby star systems there. During May, Fred obtained spectrograms of several program stars using the 74-inch telescope at David Dunlap Observatory near Toronto, Canada. In June, he described the possible double-star nature of the subdwarf star AC + 54° 1646-56 at the American Astronomical Society Meeting in Atlanta, Ga.

John E. Preschlack has assumed the presidency of General Binding Corp. of Worthbrook, Ill. . . . **John McNary** has been appointed Academic Dean of Mercy College of Detroit. Dr. McNary had been lecturing in chemistry at the University of New Hampshire following his return from Europe in 1976. For the previous five years, he was President and Academic Dean of the American College of Switzerland.

Phil Sayre sent the following note: "As of June of this year, I retired from active flying as a lieutenant colonel command pilot in the reserves, having flown 17 different types of Air Force aircraft over a period of 22 years. Harriet and I are living in Guilford, Conn., as we have been for the past ten years and I am President of Sprague Textron, one of Textron's small divisions that is headquartered in Bridgeport, Conn. Guilford is located precisely at the midpoint of Interstate 95 between the New York line and the Rhode Island line, and we would certainly appreciate hearing from anyone in the Class of '54 that is traveling by. Three of our four children are still at home but it will not be long before the two currently in high school will be away at college. I recently returned from the Convocation of Sloan Fellows which gave me a chance to get back to the Institute for a few days. I was at the Institute in 1972 and 1973 and graduated with the 1973 class of Sloan Fellows. While there I took a look at the Ralph Landau building. The excellent facilities plus the trend away from humanities and science back into engineering is most encouraging. Harriet and I made a brief stop in Hawaii on our return from Australia last year and had a pleasant conversation with **Joe Bova** who seems to be doing very well with Castle and Cooke. Nothing really spectacular happening in our lives, but we would certainly like to hear from any of the 1954 Course X people who may be in the area."

Committees are being formed to plan *our* 25th Reunion. Volunteers are needed now. Is there anyone out there? You don't have to live in the Boston area to lend a helping hand. Contact: **David Howes**, Secretary, Box 66, Carlisle, Mass. 01741; or Assistant Secretaries: **Chuck Masison**, 76 Spellman Rd., Westwood, Mass. 02090; **Lou Mahoney**, 14 Danby Rd., Stoneham, Mass. 02180

55

We are the proud recipients this month of considerable information from you out there. The time lag in these reports being what it is, we have a number of items which accompanied May-June contributions to the Alumni Fund. Be that as it may, we welcome your notes however supplied and, I dare say, the Fund will also welcome your continued gifts. Turning to the business at hand, our reporters are spread afar. Thus, **Charles A. Geilar** writes from Copenhagen that, after nine years as Head Master of the Copenhagen International School, he is returning to Boston for a year to rest and to raise funds for an international center in Copenhagen in support of international understanding. "Anyone interested?"

From Seattle, Wash., **Max Musgrove** advises that he has been involved over the past three years in the formation of an organization, "Can Do," which conducts "hands on" skill classes for mixed age groups, providing programs of greater depth than otherwise available in his community.

Closer to home, **John N. Rossettos** tells us that he has been promoted to a full professor in the Department of Mechanical Engineering at Northeastern. John was formerly a senior staff scientist at Avco and at the N.A.S.A. Langley Research Center, and has been teaching full time at Northeastern since 1969. He is the co-author of a text (M.I.T. Press) on *Finite Element Method—Basic Technique and Implementation*, which had its first printing in January and, according to John, is selling well. Royalties plus consulting for Tupperware facilitated a six-week vacation in Greece for John and his family last summer.

Our California contingent is also quite active. Thus, **Herman Jacobs** tells us that since May of 1976 he has been back on his own doing organizational development work. Bud opened a Los Angeles office in April of this year. He advises that his 15-year-old daughter, a would-be doctor, showed a sudden interest in Tech after a visit last year, that his 12-year-old son had a bit part in a recent CBS Special, and that his wife Carey is now employed full time, after receiving her master's degree as a children's librarian. Obviously, as Buddy notes, his entire family has been working "both smarter and harder."

John Johnston reports from the San Francisco area that he is currently with the Radio Physics Laboratory of The Stanford Research Institute.

Back in Los Angeles, **David Kramer** tells us that he is still with the Atomics International Division of Rockwell International as manager of a materials research and development unit. He is active in the A.I.M.E. and A.S.T.M. Dave's wife, Sandy, is enrolled at California State, Northridge, as an anthropology major. The Kramers have two children, Michael and Maura, ages 16 and 19.

To conclude the California report, **DuWayne "Pete" Peterson** wrote from Los Angeles that in March he joined the Security Pacific National Bank as Senior Vice President — Automated Data Processing. Pete is in charge of all electronic data processing and automated operations for the bank. He reports that he and his family enjoy being back in southern California after 14 years away, and invites all to "come see us" in Tarzana.

Incidentally, one brief word of warning to all you Californians. Your New York correspondent is currently spending more than half his time in the "Southland" — and might just take up some of those invitations.

Turning from geographic to professional activities, **John Morris Dickson** authored a recent editorial in *Progressive Architecture* on the subject of "socially useful architecture."

Ed Wahl is also a recent author, Wiley having recently published Ed's book, *Geothermal Energy Utilization*. Dr. Wahl, B.S. and M.S. in Course X, until recently directed the Geothermal Research Program of the Occidental Research Corp. in Laverne, Calif. Ed, another of our California contingent, has more recently started his own company involved in the manufacture of specially coated papers, plastics and fabrics "in rolls."

On the Vice Presidential theme, **Gil Davidson**, Ph.D., Nuclear Physics, has recently been appointed Vice President and Technical Director of PhotoMetrics, Inc., of Lexington, Mass. Dr. Davidson is in charge of PhotoMetrics' programs in material specification, optical detection and image processing, and is also involved in marketing projects in these areas. Prior to joining PhotoMetrics, Gil was Corporate Vice President and Division Manager of Infrared Industries in Waltham and prior to that time, had similar responsibilities at A.S.&E. in Cambridge.

Another Course X man who has obviously made good (it warms the cockles of your New York correspondent's heart) is **Norm Robbins**, B.S. and M.S., Course X. Norm was appointed last April as Vice President for Research of Inland Steel Co. in Chicago.

Finally, **Hal Austin, Dick Bergman, Gene Davis, Bob Dawson, Jim Eacker, Gustav Kabeschat, Harry Schrieber, Denny Shapiro** and myself attended the Alumni Officers Conference in Cambridge in October. We always seem to meet Harry Schrieber at these conferences, enroute from one city to another in his consulting duties. Harry advised that he is the Chairman of Close, Martin, Schrieber and Co., Management Consultants, with offices in Washington, San Francisco, Chicago and St. Louis. The firm serves as management consultants to retailers throughout the country. He still finds time, however, to devote to his daughter who attends the University of Southern California, and his son who is an AllAmerican breaststroker at William and Mary College.

It was fun receiving all this news and we hope you keep it up. Send news to — Cosecretaries: **Marc S. Gross**, 3 Franklin Court, Ardsley, N.Y. 10502; and **Allan C. Schell**, 19 Wedgemere Ave., Winchester, Mass. 01890

56

Roy Mennell has a thriving real estate brokerage in Newton, Mass. He and Shelia were married last year, and have Roy's five children plus her two living with them. He consulted in operations research at A.D. Little following his S.M., and later founded the Operations Research Group at H.P. Hood Mill Co., and continued applying computerized corporate models as the founder of Applied Decision System Computing, Inc., in Wellesley. Roy reports that the travel schedule of consulting loses its appeal after a decade of his new business, and prefers his new lifestyle.

Alan Spahr of Bible Hill Rd., Clarement, N.H., feels similarly, and has started a real estate investment and development firm. For 15 years after graduation, Al sold computer equipment for Analex, Memorex, and Storage Technology. He joined Forest Products Co. in New Hampshire until starting his own firm in 1973. He and Joan have three daughters. . . . **John Morefield** is still head of Morefield Communications, Inc., in Camp Hill, Penn., and he enjoys life on a gentleman's farm. Mary Ann is the minister of the local church.

Don Robinson is Director of Ship Preservation at Mystic Seaport, and reports he really enjoys the job and lifestyle. . . . **Robert Kissner** is President of Information Automation Inc. in White Plains, N.Y., applying computer systems to improve manufacturing productivity. He lives in Weston, Conn. . . . **Jerry Vielehr** has moved from President of Aqua Chem Inc., in Milwaukee, to become Vice President for International Trade at Coca-Cola in New York City, and reports that he enjoys living in the City. . . .**Merlin Lickhalter** has been elected President of the newly-formed JRB Architects, Inc. which will provide architectural, planning, consulting and engineering services. Their headquarters are in St. Louis, Mo., with additional offices in Washington, D.C., and LaJolla, Calif. — Co-secretaries: **Bruce Bredehoft**, 7100 Lanham Ln., Edina, Minn. 55435; **Warren G. Briggs**, Deree College, Box 472, Athens, Greece. (September 77 to July 78.)

57

There really isn't much news to share with you, at this time. I'm busier than ever with my new job and really love the challenge. I've been in touch with Professor **Ed Roberts** and he'll write a preliminary report on the class questionnaire that was distributed at the reunion. Hopefully, we'll hear from him next month. I'm still unable to supply you with a final report as the information is still being computerized for us. Since last month, I haven't heard from many of my fellow graduates but here is some news we'd like to share.

Paul R. Duevel has been promoted to the position of Purchasing Agent with King-Seeley Thermos Co. in Norwich, Conn. He has been employed by them since 1961 after his release from active duty in the U.S. Navy. Since joining Thermos he has held management positions in Production Control and most recently Quality Assurance. He and his wife Janet and two daughters reside at 33 Coit Lane.

Gary J. Dischel wrote that he is busy working on New Hotel in El Salvador which my company Knightsbride Hotels will operate. When open, in early 1978, it will be Central America's first major beach resort.

And to conclude our news for this month, so we'll make the *Tech Review* deadline, a word from Boston. General Agent **Robert M. Palter**, Chartered Life Underwriter with National Life Insurance Co., was among 22 selected field executives who participated in the firm's annual general agent's management seminar in Montpelier, Vt. Robert led a discussion on agent selection during the seminar, which centered its workshops, panels and other sessions on financial, manpower, operations, management and human relations aspects of life insurance field offices. He has been in the life insurance business since 1966 and joined National Life of Vermont the following year as an agent in Los Angeles and became head of the firm's Boston general agency on June 1, 1976. — **Fred Morefield**, Secretary, 285 Riverside Dr., #6-A, New York, N.Y. 10025

58

Snow, rather than leaves, should be falling by the time these notes cross your view. Aha! Speaking of the view, it's time to look ahead to the 20th Reunion next June 9-11 on Martha's Vineyard at the Harbor View Inn. You've surely heard by now what a terrific time we had at our last reunion held at the Harbor View. If you missed the 15th, you'll love it. If you attended the 15th, you'll like it even more because the committees have great, new and exciting things in store for you. Somehow, when the boat leaves the dock in Woods Hole, bound for the Vineyard, it's not only a reunion but a mini-vacation for everyone. Come and enjoy!

Moving from sales to production, **Bernie Schneiderman** has been named Manager of Hawaiian operations of the Vought Corporation Advanced Technology Center. He has been with Vought for a year working on problems associated with the Navy's Tactical Development Program and prior to that served with the Center for Naval Analysis for eight years. He invites old friends passing through the Hawaiian area to give him a buzz. . . . **Herbert Kavet** is living in Wayland, Mass., with his wife Karen and their sons Greg (9) and Matt (6). Herb is presently the Chief Executive Officer of American Publishing Corp., a company which he founded in 1962. . . . **Tom Reed** is moving from Massachusetts to Golden, Colo., where he will direct the biomass-fuel program at the Solar Energy Research Institute. Recently, Tom has received a lot of publicity as "Mr. Methanol" as a result of his experiments with methanol as an automotive engine fuel.

Stan Fenster has joined ITT Avionics in Nutley, N.J., where he is a senior member of the technical staff. . . . **John Collins** presented a paper at the Metropolitan Museum of Art in New York City at the Annual Meeting of the American Ceramic Circle. His topic was "Porcelain: Inquest of an Analysis". . . . Up in Montreal, **Tom Blood** and his three-year-old architectural firm have been running a "full-house" for the past year with a general practice ranging from experimental housing for northern Quebec Eskimos to a new church in Rochester, N. Y.

Penny and **Richard Nyder** have been living in the San Francisco Bay Area for about two years with their children Katrina (7) and Derek (5). Dick was recently promoted to the position of Marketing Manager at E-H Research Laboratories after spending several years as a regional sales manager. During this past summer Dick spent the entire month of June in Europe on a new product introduction program. . . . It has now been confirmed by a reliable source, **Sars McNulty** himself, that he is alive and well and has been with Xerox for the past 19 years since leaving Tech. For the last several years Sars reports that "I've been program manager of several product development programs and am currently manager of the copier and duplicator technical staff. I received an M.S. in mechanical engineering, as well as an M.B.A. from the University of Rochester. Mary and I now have three children, a daughter, 14, and two sons aged 12 and 6."

Lawrence Caselini has been appointed Secretary in the Engineering Division of the Casualty-Property Commercial Lines Department at the Travellers Insurance Companies in Hartford. Larry has been with the Travellers since 1971 after several years in the aerospace industry. Larry and his family are living in South Glastonbury, Conn. . . . **S.C. Chen** is practicing otorhinolaryngology and facial plastic surgery in Freemont, Calif. He and his wife have two children aged 10 and 8.

Another note in the mail bag this month is from **Willard Fraize**, who notes that "I am enjoying my work in the Fossil Energy Systems Engineeirng Department of the Metrek Division of MITRE Corp. In my spare time, I play the trombone, fix clocks, and garden. Enjoy raising (i.e. keeping up with) my four kids in Reston, Va."

That's all the news for this month. Remember that sunny, warm weather and the reunion are just around the corner. On a clear day you'll be able to see nearly all your classmates and friends on the Vineyard. — **Michael E. Brose**, Secretary, 30

59

Wihout those cards or letters there is little to report. **Nam Suh**, Professor of Mechanical Engineering at Tech, and his colleagues were featured in the August issue of *Wear*, an international journal of friction, wear and lubrication of materials. . . . **Jonathan Weisbuch** reports from his position as health officer for the State of North Dakota. His major responsibilities include overseeing environmental programs in air and water quality as well as enforcing the Health Planning and Resource Development Act of 1974.

On the local scene, the Alumni Association announced the appointment of **Ron Stone** as Special Assistant to the Executive Vice President. Ron's expanded responsibilities will include the general supervision of the operations of the Alumni Fund in addition to his activities as Regional Director for the West. The Alumni Officers' Conference in October provided an opportunity to quickly say hello to **Phil Richardson**, briefly taking time out from his hectic pace in New York; **Steve Denker**, also visiting from the Big Apple; **Bob McAuliffe**, now expanded with his consulting business to have offices locally and in New Hampshire; and **Dick Sampson**, who is now actively directing the growing fortunes of a home and industrial security systems company.

That is all for now. Remember, **Phil Richardson**, 180 Riverside Dr., New York, N.Y. 10024; **John Amrein**, 770 Greenwood Ave., Glencoe, Ill. 60022; **Adul Pinsuvana**, A.S.E.A.N. Secretariat, 6 Jalan Taman Pejambon, Jakarta, Indonesia; **Bob Muh**, 907 Chantilly Rd., Los Angeles, Calif. 90024; or **Allan Bufferd**, 8 Whitney Rd., Newtonville, Mass. 02160

61

Jerry Milgram is secure in his job at M.I.T., as Professor of Naval Architecture.

A lot of people are acquiring major responsibilities and honor these days. **Bob Katz**, who works in the Ceramics Reseach Division at the U.S. Army Research Center in Watertown, Mass., is now a Fellow of the American Ceramics Society. . . . **Bruce Bardes** is Editor of the *Metals Handbook*. . . . **Joe Harrington** is Chairman of the Citizens School Advisory Council in Westborough, Mass. He also is on the Visiting Committee for the M.I.T. Humanities Department.

Peter Hertan manages the A.P.L. project [whatever that is] for I.B.M. in Los Gatos. . . . **Peter Fishman** won the Washington, D.C., Academy of Sciences Annual Award for Biological Sciences for his research on gangliosides as biotransducers of membrane-mediated information. . . . **George Gladfelter** finally got his own computer at the South Dakota School of Mines and Technology — a CDC 6400 operating under KRONOS. Congratulations! . . . **Bob Creasy** writes that he took a trip to the Peoples Republic of China and recommends it without reservation. He didn't say why he was there.

Tony Silvestri, who has kept mum all these years, writes that he has a Ph.D. from Stanford, got married, moved to Boston, moved back to the San Francisco area to work for E.S.L. and now lives alone with three sons in San Jose. He says that he swims a lot to keep in shape. . . . **Rich Garvine** wrote to say that he moved from the University of Connecticut to the University of Delaware last July, where he is now an Associate Professor in the College of Marine Studies and continues his work in physical oceanography. Last summer I went off to Italy for a month and recommend it to one and all. The people are charming, the scenery magnificent and varied, and the art. . . .

I'm sorry to report the death of **Maurico Borgonovo** who was in course II. He was Foreign Minister of El Salvador and was excecuted by terrorists last May after being kidnapped in mid-April. His murder took place in spite of appeals by Pope Paul and U.N. Secretary General Waldheim. It is chilling when people you know are in the headlines. — **Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, Mass. 02167

62

Apparently, our 15th Reunion was cancelled due to lack of interest. I guess that means that I'm still the secretary for the time being although I'm always open to volunteers. Linda and I went to Europe earlier this year, and stayed with Gail and **Gordy Mann** while in Belgium. They live in Limal, a suburb of Brussels and Gordy is Managing Director of WABCO Manufacturing in Gembloux, Belgium. . . . **Michael Kottler** is now Assistant Professor in the Ophthalmology Division at University of Utah. . . . **Francis Berlandi** has received comprehensive certification as an industrial hygienist from the American Board of Industrial Hygiene. He has also been appointed as Manager of Environmental Services for ESA, Inc. in Bedford, Mass. He and his wife Cheryl are now living in Winchester, Mass. . . . **Herbert Selesnick** is now a Group Vice President at Harbridge House, Inc., management consultants. He published a book in May of 1976 about rent control.

Edward Feinberg is now an environmental scientist for the New Jersey Department of Environmental Protection, working with remote sensing applications. He married the former Linda Jonas in 1973 and they have a son, Adam Walter, who was born in June. Linda is an assistant county prosecutor. . . . **George W. Meyer** relocated to Biloxi, Miss., in 1976 and is currently a gastroenterologist at the U.S.A.F. Medical Center at Keesler A.F.B. He welcomes any old classmates who are ever in the area. George regretfully informs us of the death of **T.J. Lageman** in June. His widow Marge and the kids are doing OK in California. . . . **Kenneth Wang** is now a Senior Research and Developement Engineer doing corporate research and development for Burlington Industries in Greensboro, N.C. He and his wife have three children, Rebekah, 11, Angie, 8 and Joshua, 7. He would love to hear from you by mail or see you if you are in that area. . . . **George Ioup** is currently an associate professor of physics at the University of New Orleans and his wife, Juliette Wingfield Ioup, is associate professor of physics at Xavier University.

After spending an interesting year as a visiting lecturer at U.C. Berkely, **Alan Kotok** has returned to Digital Equipment Co. and is once again designing their large computers. He ended his long bachelorhood in March when he married Judith Beck. They are now living in Stow, Mass. **Richard Laeser** is now Operations Manager at (CalTech) JPL for the Voyager flights to Jupiter, Saturn and maybe Uranus, launched in August and September of this year. . . . Except for a year in Geneva, Switzerland, **Andris Faltens** and his wife Marjorie have been living contentedly in Berkeley where he is working at LBL on accelerators, specifically on heavy-ion inertial fusion. Marjorie received a Ph.D. in nuclear chemistry from Berkeley in 1969 and works for the University. They have a daughter, 10, and two boys, 5 and 7. . . . **Elwyn R. Berlekamp** is a recently elected member of the National Academy of Engineering, a private organization which shares in the responsibility of advising the

federal government on matters of science and engineering, as well as sponsoring engineering programs aimed at meeting national needs. Elwyn is now doing research in information and coding theory and their applications to communications and computer memory systems at U.C. Berkeley.

Harvey E. Cline recently assisted in a significant invention in production of semiconductor components for G.E.'s Research and Development Center in Schenectady, N.Y. . . . **David N. Wormley** was promoted to the rank of full professor at M.I.T. in July. He is with the Department of Mechanical Engineering. . . . .**H. David Stein** is now an Assitant Professor of Surgery at the Albert Einstein College of Medicine and is teaching as well as carrying out a private practice in surgery at the Albert Einstein College Hospital. . . . **Donald W. Horner** started a new job as Principal Senior Engineer with Motorola GED in Scottsdale in June of this year. . . . **Steven Root** writes that he is still programming at Digital and also is still playing bridge, poker and softball. . . . **K. Moriyasu** is currently Assistant Professor of physics at the University of Washington. . . . **David Butler** recently spent a month in India consulting for a U.N. sponsored geothermal search team using microseismic techniques. He and his wife Francine live in Golden, Colo., with their 8-year-old daughter, Dana. David still teaches at the Colorado School of Mines and runs his own company. His wife is now pursuing a Ph.D. in psychology. . . . **Theodore Labuza**, now a Professor of Food Science and Nutrition at the University of Minnesota, recently participated in a Nutrition Symposium sponsored by the Breakfast Cereal Division of General Mills and presented his research on food additives. . . . **L. McCloskey** continues to run company specializing in supplying marine navigation systems for offshore oil and mineral exploration. — **Gerald L. Katell**, Secretary, Watt Industries, Inc., 1623 26th St., Santa Monica, Calif. 90406

63

Short column this month. Just a few flaps, a few press releases, and one brief letter. The letter, from **Ron Walter**, informed us of his recent appointment as deputy chancellor of the New York City public school system. Ron will be the school system's chief fiscal officer, and will have responsibility for all its business and management aspects, including the Divisions of Personnel, Business and Administration and School Buildings. Prior to joining the Board of Education Ron served as an assistant to the Mayor of New York, advising on budget, policy and operational issues. His letter says that ". . . one day I will try to describe this as a logical progression from Course I." I wonder how many of us can still be labelled with the same professional labels we had when we left M.I.T. Ron, his wife Marilyn, and daughter Amy, 3, are living in New York City's "new town," Roosevelt Island.

John Wasserlein reports that he is still Division General Manager of Boise Cascade's Specialty Paperboard Division and president of five of Boise Cascade's subsidiary corporations. The division has grown to eight plants in New England and New York State, with headquarters in Brattleboro, Vt. John is active in civic and community affairs, and recently served as president of the Brattleboro Memorial Hospital. He has two children, and his wife Rita reports another one on the way. To accommodate the growth of their family, the Wasserleins are moving to a new home in Dummerston, Vt. To relax from all this activity John and Rita spent a recent vacation bicycling 800 miles through southern France and Corsica.

James Anderson wrote that his engineering firm, J. Hilbert Anderson, is designing and constructing the first hot water geothermal power plant in the country. It is being constructed in the Imperial Valley in California. His other company, Sea Solar Power, has pioneered the development of power from the temperature differences in the ocean. They have preliminary designs and plan for the full-scale development of the project.

Two short press releases inform us that **Robert Efimba** has been elected Secretary of the National Capital Section of the American Society of Civil Engineers. Bob is assistant professor of civil engineering at Howard University. **Howard Leibowitz** has been appointed director of Machine Technology at Corning Glass Works in Corning, N.Y. Howard has been with Corning since 1965.

As of this writing (early October) we haven't had any mailings regarding our upcoming 15th Reunion. This material will be forthcoming shortly. However, in the meanwhile you can plan on reserving some vacation time in early June (first or second week) for a visit to New England. Let's have a record turnout this time. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, Calif. 92715

64

Greetings '64. Here I am at the Arabella Hotel in Munich, Germany, writing an already one-week overdue set of class notes. Perhaps more about my trip later, but first to the business at hand.

It is with great sadness that we must report the death of another classmate: **Michael J. Murray III** of Princeton, N.J., passed away July 4, 1977. Our sympathy and condolences to his widow.

We had one class hero in the past month, **Kenneth Kaiser**. He is project architect for Jones and Jones, a Seattle firm of architects, urban designers, and planners. For anyone wishing to get in touch, Ken included his home address: 1000 First Ave. West, #105, Seattle, Wash. 98119.

Alumni envelopes provided slim pickings this month. Last year's Challenge Fund apparently was so successful that the same challenge is being made by a group this year. So keep those envelopes coming, preferably the ones marked "increase" in italics, or however else the Institute chooses to indicate 77-78 Challenge contributions. Just remember, it's not often you can make $1.00 work like $2.00 and get a tax deduction for the $1.00 to boot. And get your name in print all at one fell swoop. Rise to the Challenge, again.

Bill Remsen is currently staff engineer for General Atomic Co. He writes that he is "mostly enjoying the sweet life here in San Diego — living on the beach and raising a family." . . . **John W. Meriwether, Jr.** has moved to the northwestern corner of Puerto Rico so his wife can commute 90 minutes to her lab at the Marine Botany Institute at La Parquera. John commutes with other Arecibo Observatory scientists 90 minutes by mutually-owned van. The Meriwethers are planning an October vacation in St. John, U.S. Virgin Islands. . . . The First National Bank of Maryland in Baltimore has announced that its Board of Directors elected **Henry Schofield Noble** to the position of Vice President. In this position, he is responsible for both trust administration and the settlement of estates. Henry is currently serving as President of the Maryland Chapter of American Mensa, Ltd.; he is also a member of the Maryland (State) Bar Assocation and American Bar Association.

For those of you who follow this column's ramblings, you'll recall my telling of a hectic travel period during February/March/April of this year. I managed not to travel for business (an accomplishment for me) between April and September. At the end of September, I was in the soup again. A week in San Diego, now a week plus two weekends in Germany, and a week in New England at the end of October. This week is for the semi-annual I.E.E.E. ATLAS Conference. ATLAS (Abbreviated Test Language for All Systems) is used throughout the U.S. and Western Europe for electronics and avionics testing. To accomplish some parity of travel burden, every third meeting is held in Europe. So this week I am in the charming German city of Munich. It is exceptionally clean and has a very picturesque mixture of architectural styles, not to mention some great restaurants and delicious beer. One gets along reasonably well with mostly English and a word or two of German. All the people whom I've met are friendly and courteous, though the apparent penchant for precision and definitiveness can occasionally be mistaken for abruptness. A group of us enjoyed a delightful meal at the Rathskeller near Munich City Hall on Marienplatz last night. No one spoke German, but our waitress was of Portuguese descent and one of our party served as group interpreter in Spanish! It's a small world. I'm running out of room. Next trip next month. Please write! Please remember M.I.T. with your contributions! — **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, Md. 20854

65

Well, classmates, the column this month appears only thanks to the news releases forwarded to me. If you do not get our your trusty pens to write, next month may show a blank space where '65 should be. **Margaret (Scotty) MacVicar**, who is Associate Professor of Physics at M.I.T., was recently elected to the Corporation of Boston's Museum of Science. She also serves on the advisory committee to the Museum's Education Department. . . . **George McKinney**, who got a Ph.D. from Stanford since leaving the 'tute, was promoted to business development manager of Consumer Products for Corning Glass Works.

Ronald Newbower is Chief of the Bioengineering Unit of the Harvard Anesthesia Center. In September he spoke to the Engineering in Medicine and Biology Chapter of I.E.E.E. about the Boston Anesthesia System, an integrated anesthesia management system being developed at the Mass. General Hospital. . . . **Dick Schmalensee** has returned to M.I.T. as Associate Professor of Economics with permanent tenure. After receiving his Ph.D. from M.I.T. in 1970, Richard went to the University of Californa as Assistant, and then Associate, Professor of Economics. He spent a year as Visiting Professor at the University of Louvain in Belgium, and has served as a consultant to the Federal Trade Commission.

Going from the sublime to the ridiculous, we replaced our late St. Bernard, Bruno, with two cats. One of them did not make it to the vet on time, and we now also have two kittens to add to the menage. Please write. — **Edward P. Hoffer**, M.D., Secretary, 12 Upland Rd., Wellesley, Mass. 02181

66

I spent this past wekend at the Alumni Officers' Conference at the Institute. Friday night got together with Pat and **Bill Kosinar.** Bill is still with New England Mutual Life Insurance Co. and Pat recently started a management training program for women.

The mail is somewhat scant to say the least. **Paul Aita** writes that after over a year as a volunteer chaplain with the Tacoma Police Department he was made coordinator of the Chaplain Program in June, 1977. He ran into **Paul Stamm** while in San Diego attending the bienniel convention of the American Baptist Churches, U.S.A.

W. Bruce Wallace writes that he's been associated with the law firm of Stock and Leader in York, Penn., since graduating from Dickinson Law School and passing the Penn. Bar Exam in 1974. He is primarily involved with pension, corporate and tax law. He and wife, Pat, have two children, Brian, 4, and Suzanne, 1.

I'll need some news if I am to keep up these notes. — **Paul Rudovsky**, Secretary, 340 East 64th St., New York, N.Y. 10021

67

The Bicentennial Award goes to Tammy and **Greg Wight**, the proud parents of a two-pound baby boy born July 4, 1976, who has recovered from a slow start to become the terror of the household. Greg is with the Connecticut Department of Environmental Protection striving to make Connecticut's air fit to breath. . . . **Chuck Greene** married Jan Simpson last June in Toronto. He recently dined with Aileen and **Paul Goldstein**

during their visit to Toronto for a doctors' convention and caught up with the news of some friends out there who read *Technology Review* but don't write: Hank, Joey, Al, Andy and Fish.

Having left the Corps of Engineers in San Francisco, **Tom Hughes** is in southern California helping to develop the space shuttle facilities at Vandenburg. . . . **Frederick Hottes** writes from Salt Lake City: "**John Ebert** stopped by last winter to visit while trying to ski during the worst drought on record. Since graduating I married Lorraine Adamski, a Northeastern mathematics major, in June, 1972, and finished medical school in June, 1975. Our daughter Alison was born February 4, 1976, during the height of a major snowstorm (in a nondrought year). I am currently doing a pathology residency." . . . After working several years at the M.I.T. Computation Center, **Arnold Lieberman** is now a systems engineering consultant at Data General Corporate headquarters in Westboro, Mass. Having worked in both the "ivory tower" and the "real world," he says he cannot tell them apart. . . . **Richard Rush** is Visiting Assistant Professor of Architecture at Carnegie-Mellon University. He expects to publish a short article on senufo architecture in *Technology Review* in the near future. . . . After spending four years building their dream house on six acres in Florida, **Bob Landley** and his wife decided to move 7,000 miles to Kwajalein in the Marshall Islands, where Bob works for RCA on an experimental laser radar project. — **Jim Swanson**, Secretary, 669 Glen Rd., Danville, Calif. 94526

68

Welcome again from your nation's capital. It may be December now, but it is none too early to start planning to be in Boston in June for our spectacular tenth reunion. You should be receiving another mailing about this right after Christmas. Which brings us to an important issue. If you will think back to 1968, you may remember certain events taking place which may have made it desirable to receive one's degree at a time other than June, 1968. The Alumni Association in some respects is an uncreative organization; that is, it could not come up with a simple rule for identifying who is in the Class of 1968 except by date of degree. Therefore, there are many people who probably consider themselves in our Class who are classified otherwise by the magic computer. If the computer thinks you are in our Class you received a questionnaire last June about the reunion. If you did not receive this questionnaire and you feel that you want to be listed with the Class of '68 and come to its reunion, please drop us a note and we'll get it straightened out.

With that administrative note we can get on to the few news items we have this month. **Jonathan Shane** has joined the Bank of New York as an

Jonathan Shane, '68

Assistant Vice President in the Investment Research Department. . . . Major **Joel Tepper** has been transferred to Andrews Air Force Base, Md., where he is Chief of Radiation Therapy. . . . Back at the 'tute, **Dany Siler** has been named Assistant to the Director of Admissions and will be primarily responsible for statistical analysis while working on general admissions, recruiting women, and interviewing prospective students. After graduation she worked for three years as a Research and Administrative Assistant at the Sloan School with Professors Edgar Schein and Lotte Bailyn on an evaluation of higher education in science and technology. In 1972 she moved to Berkeley to work as a Programmer and Research Assistant at the Social Action Research Center, evaluating training programs for mental health paraprofessionals. While in Berkeley she studied and taught weaving and textile crafts. Leaving the area in 1975, Dany traveled extensively throughout North America, crossing the continent three times and visiting 36 states and four Canadian provinces before moving back to Belmont, Mass., in 1976.

That's all we have for this month; please drop us a line and tell us what you've been doing for the past nine years. Season's greetings to all and we'll see you next year. — **Gail** and **Mike Marcus**, Secretaries, 2207 Reddfield Dr., Falls Church, Va., 22043

69

Robert A. Sable writes that his new address is: 2500F Johnson Ave., Bronx, N.Y. 10463. Robert is finishing his final year as a gastroenterology fellow at the N.Y. Medical College. . . . **Stephen Lee Weinberg** is back to Berkeley (Box 127) after a year in Europe. . . . **Don J. Lapenas** is now at Emory University, by way of the University of Pittsburgh School of Medicine where he was an instructor in pathology. Don is an assistant professor of pathology at Emory.

Paul Kudirka has been appointed Assistant Patent Counsel by Digital Equipment Corp. Paul had been on Bell Labs staff in N.J. most recently as a member of the Legal and Patent Staff. He will be responsible for patent, trademark, copyright and licensing matters for D.E.C.'s Education Products, Field Service Groups, and the Terminals, Disc and Tape Engineering Groups in Central Engineering.

That's all folks. Season's greetings. — **Peter Peckarsky**, Secretary, 950 25th St. N.W., Washington, D.C. 20037

70

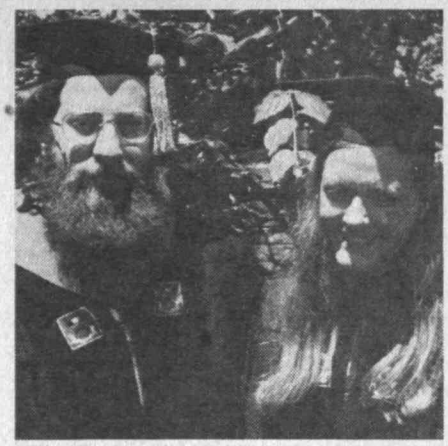
Seasonal Greetings. **Joseph Kubit** has changed employers from Atlantic Richfield to General Manager of James Huggins, Inc. and Huggins Export Co. . . . The N.A.S.A. space shuttle may carry Captain **Michael Sheaffer**, who has been selected by the Army to compete for astronaut positions. . . . **James Lockner**, chairman of the Brandeis psychology department, was appointed the Meshulam and Judith Riklis Associate Professor of Behavior Science. He will concentrate upon human spatial orientation and movement control.

Maggie and I have been attending state bar functions and planning a ski vacation for this month. I am hoping to increase my litigation skills by accepting a part-time position with the prosecuting attorney. — **Robert Vegeler**, Secretary, 2120 Fort Wayne National Bank Bldg., Fort Wayne, Ind. 46802

71

Seasons Greetings! I attended an alumni picnic in Houston in September and met a number of fine people. I saw **Andrea Sanders** of our class who has recently moved to Houston. . . . **Oljan Repic** married Susan Persa (Chamberlayne College) in 1971, worked at Eli Lilly that summer and finally received his Ph.D. in organic chemistry from Harvard in 1976. His reward was a daughter, Oriana, and a white Mercedes — both from his wife. After a trip to Europe on the *Queen Elizabeth II*, he joined Sandoz, Inc., East Hanover, N.H., as a Senior Scientist.

Joseph C. Runkle was the first recipient of the Falih N. Darma Materials Achievement Award for academic research and extracurricular achievement. Joseph has authored and coauthored numerous technical papers in various phases of metallurgy and is currently studying elevated



Howard and Leah Siegel, '71

temperature fatigue of nickle-base superalloys for his Ph.D.

Pat Cunningham married Judy Lazrus in 1976. He is in the master's program in child study at Tufts where he is a graduate assistant in the Eliot-Pearson Children's School.

Princeton sends the following news release: "When **Howard** and **Leah Siegel** received their Ph.D. degrees in electrical engineering earlier this month, it was the first known time that Princeton University has bestowed doctorates to a husband and wife in the same field at the same time. The Siegels, who are both age 27 and specialists in Computer Science, have been teaching and doing research for the past year as Assistant Professors at the School of Electrical Engineering of Purdue University in Indiana. They returned to Princeton for commencement exercises June 7, having completed their four years of graduate work here in 1976. They had met as undergraduates at M.I.T. and were married the summer after graduation in 1972. They live in West Lafayette, Ind., with two cats and a 130 pound St. Bernard named Pooh." Quite an achievement!

Chris Brewster wrote me a nice letter (which I managed to misplace) about his job in London. He sounds happy and interested in his work.

Stop by Brenham if you make it as far south as Texas. — **Hal Moorman**, Secretary, P.O. Box 1808, Brenham, Tex. 77833

72

Sorry to have missed the last column, but I ended up some 7,000 miles from home in Saudi Arabia when the deadline passed. June saw our fifth reunion, and a good deal of thanks is due to those on the committee who came up with very enjoyable events at an unbeatable price.

John Scalea writes, "I am working for MITRE on air transportation research, where Don Garvett, '73, is my office-mate. We have recently completed projects dealing with aircraft retrofit and aviation cost allocation. My wife, Ann Marie, is an instructor for Digital Equipment Corporation. We have been beating a path to Boston of late as we are completing our second album of religious music through St. Clement's Student Parish, 1105 Boylston St., Boston, and it is also available through me in Falls Church, Va. (2203 Iroquois Ln.), if anyone is interested."

Rafael Bras, now an assistant professor of Civil Engineering at M.I.T., received an N.S.F. Engineering Research Initiation Grant. . . . **William DePietro** has began his dermatology residency at Columbia University, St. Lukes Hospital. . . . **Charles Thomas** teaches structural analysis and design in the engineering department at West Point. . . . **Jordan Carter** is product manager for chemicals and supplies for Waters Associates, in the liquid chromatography field. . . . **Richard Eckert** is an electronic warfare officer in the air force at Loring A.F.B. in Maine. . . . **Carliss Baldwin** is now an assistant professor of finance at

Sloan after finishing her doctorate at Harvard Business School. . . . **Gerald Billes** is working in his architectural and planning firm, Hayden-Billes Associates, and is renovating a Victorian two-story house in New Orleans' historic Algiers Point district.

Charles Hanf reports that he worked a year after leaving M.I.T. before entering med school. He is now married and has a 16-month-old daughter, and has also started his surgery residency. . . . **Marietta Millet** is an Assistant Professor of Architecture at the University of Washington, teaching lighting and working on research project in energy conservation in building design. She is divorced and moved to Seattle last year with her son Alex, 3. . . . **Shirley Wilson** has been teaching math at Auburn University, Montgomery, Ala. She writes, "A.U.M. was started in 1969 and is still growing, so it's a dynamic place to be. Good students, a young faculty, and warm, friendly people make my job fun. The winter was colder than usual, but pleasant for a Yankee girl."

Bruce Schwartz writes, "I am finishing law school at night while working full time as a legal analyst for the New Jersey Dept. of Environmental Protection. I am looking forward to sleeping again in the fall. Having declined to the status of petty bureaucrat, I can probably go no lower — but at least I'm not selling used cars or insurance." . . . **Steven Shantzis** is a senior consultant with International Energy Associates in Washington, working mostly with international nuclear and domestic solar matters. He lives in northern Virginia and sails on the Potomac and Chesapeake. . . . **Faruq Ahmad** writes, "After an M.S. from Stanford and an M.B.A. from the same sunny country club, I am back in Cambridge, working at a small consulting outfit in Harvard Square. In between trips to New York, I've renewed old friendships (people never seem to leave this place) and rediscovered the joys of neighborhood living and the Boston/Cambridge lifestyle." . . . After getting his master's in Chem. E. at M.I.T., **Lewis Jester** went through Harvard Business School. He graduated in 1975, married Suzanne Itkin (Wellesley '75), went to work for Standard Oil of California in San Francisco in their comptroller's development program, and is currently on assignment in the Bahamas. He writes, "After working diligently in S.F., Suzanne has become a beach bum in Freeport."

Alan Gevins reports, "I'm now Director of Scientific Computing and Director of the E.E.G. Systems Lab at the Langley Pirten Institute, University of California Medical School in San Francisco. A computer system for analysing brain electrical activity that I've been working on for five years is now complete. I'm using it to try to recognize simple cognitive states in healthy people and in patients."

Charlie Mann writes, "after four years in Washington, I'm beginning to be at home. More than two of those at Energy and Environmental Analysis, Inc. Recently helped develop coal conversion portion of Carter's energy program." . . . **Andy Himmelblau**, after living in Weymouth and working for Badger, has moved to Lexington and is working for an energy consulting firm in Cambridge. . . . **Andy Mermell** graduated last June. . . . **Sandy Warrick** and his wife have moved to Kingston, N.H., where he is president of his own boatbuilding concern. . . . **Roy Schweiker** has been working the past five years for the New Hampshire highway department and is living in Concord. . . . **Duncan Allen** is working for a transportation consulting firm in Toronto on light rail transit for Calgary.

I regret to have to pass on the news of the death of **Craig Johnson**. He was a research fellow at the Royal College of Art in London. Professor Archer of the College writes, "Craig came to this country in 1972 to work on the development of the Department of Environment's computer aided building design system and he became progressively more concerned with the problems of the naive (from the computing point of view) user. Craig was an important part of the newly formed Computing Activities Unit in the College with special responsibilites for encouraging students and staff to use graphics computing techniques. He was a major force in the revived B.C.S. Computer Aided Design Specialist Group and his main professional interest was the development of interactive graphics software for use by equipment designers. At the time of his death he had just completed a thesis on this subject. His research and teaching career was just gathering momentum and his untimely death is a great loss to the computing community in general and the Royal College of Art in particular."

Starting with the new year, **Wendy Erb** has volunteered to share the chore of this column with me. We plan roughly to alternate columns — with luck, producing a more regular and better '72 column. — **Dick Fletcher**, Secretary, 135 West St., Braintree, Mass. 02184

73

Welcome once again, ladies and gentlemen, as we set a class record for consecutive *TR*s with columns for our class.

Whether you realize it or not, it will be five years this June since we graduated. An ad hoc reunion committee will be meeting to discuss plans for our fifth and you will be receiving more detailed information in the near future. If you're interested in participating in the reunion planning, please let me know. Meanwhile save the dates, June 9-11!

Richard Schechter will complete an M.S. in systems engineering at the University of Arizona in Tucson, where he is enjoying the desert scenery and climate of southern Arizona. he hopes to find a job in the Southwest this December. . . . **John Mack** has been promoted to Associate Director of Admissions for M.I.T. John was an XI major and is currently a grad student in system dynamics at the Sloan School. . . . **Igor Frolow** has been appointed an instructor in math at Oberlin College in Ohio. . . . Lt. and Mrs. **Steve Waller** have arrived for their first Air Force active duty assignments (she's a Lt., too) at Andrews A.F.B., Md. They will serve as optometrists at the Malcolm Grow U.S.A.F. Medical Center.

It's been a reasonable month for **Tony Scandora** out in Wheaton, Ill., but the class will never know why, because he never writes. Hisssssss, Bass Italian! Yours gauntly has gotten down to 133 lbs. (that's from 176) since May, and swears by fiber in the diet. The big event (read Big Event) of this month was that on September 26 I was invited to sing the Canadian and American National Anthems at Fenway Park before a game between the Red Sox and the Toronto Blue Jays. Modesty forbids my telling what a fantastic reaction I got or how great I sounded, so I'll let you all ask about it. Doubters may come to Agassiz Theatre at Harvard in December where I'll be playing the Duke of Plaza-Toro in Gilbert and Sullivans' "The Gondoliers." Not bad, even if Ah'm jist an old country computer salesman from Nawth Ca'lina!

Au reservoir, folks, and if you want to avoid columns full of me, please wirte. — **Robert M.O. Sutton**, Secretary, 37 Fairbanks St., Brighton, Mass. 02135

75

This is going to be a quickie, as I have but two items to report. Some time ago, I received a phone call from **Woody Priebjrivat**, who, after graduation, spent a year teaching math at Thammasat University in Bangkok, Thailand. No, he did not call from Thailand. Instead, Woody called to say that he's back in the states working towards a Ph.D. in public management at the University of Chicago's Graduate School of Business.

My only other "class note" was sent to me by **Chris Dippel**, who, if you will recall, is married to **Chris Santos**. Chris (Dippel) received his master's in zoology from the University of Idaho, in Moscow. He's now going for a Ph.D. in physiology at the University of Kansas, while Chris (Santos) is studying to gain certification as a music therapist and a master's in music education.

That's it for 1977. Hope you all have very happy holidays — how about making mine happier by dropping a line? Ciao for now. — **Jennifer Gordon**, Secretary, 22 Centre St., #9, (Note the new address), Cambridge, Mass. 02139

76

News, and from the most unexpected quarters. I opened a copy of the *Milton Record-Transcript* and there learned to my surprise that **David Campanella** married Joanne Rudinsky, a girl with whom I went to high school, on June 26. Joanne was alumna of Lasell Jr. College. Dave is working for Georgia-Pacific as a Production Engineer in Louisiana. They are now living in Baton-Rouge.

Jeff Jaffe and Esther Klipper, '79, were married June 19 in Queens, N.Y. Among the classmates attending were **Gary Buchwald**, **Dan Dershowitz**, **Herbie Levine**, and **Dave Kessler**.

I went to the wedding of **Gary Buchwald** and Michele Gershman, '79, on August 21 in Baltimore. Dan and I flew down together from Boston. The wedding was great fun. Other classmates attending were Esther and **Jeff Jaffe**, and **Dave Kessler**, as far as I could see. All of us had parts to perform in the wedding, and we acquitted ourselves magnificently!

A letter from **Jean Hunter** and **Tom Hirasuna** has clarified my last issue's uncertainty as to their commuting problem, and provided some details of their wedding. They both now work for General Foods in Tarrytown, N.Y. Jean is an Associate Chemical Engineer for the Engineering Development Group, and Tom is an Assistant Chemical Engineer in Engineering Research. They now reside in Yonkers, N.Y., in a very residential neighborhood nine miles north of N.Y.C. Among the people at their wedding were the following classmates: **Ed Crawly**, **Sally Dungerian**, **Dorothy Harris**, **Bernie Tau**, and **Tom Parham**. Ed has been to the National Boy Scout Jamboree in Pennsylvania last summer. He is now a grad student in Course XXI. Sally is now working for the state of New York doing epidemiology studies and resides in Albany. Dorothy is a grad student at Harvard Med in immunology. Bernie is working for G.E. making diamonds in Columbus, Ohio. And Tom is now working for Corning Glass in Corning, N.Y., as a Pilot Plant Engineer. This is a change from his previous job in sales with Hercules in St. Louis.

I have a fascinating letter form **John Hanzel**, formerly with *The Tech*. He writes, "Since I left the 'tute, I spent over a year in Florida working for the Harris Corp. The division I was in made newspaper computer VDT systems, and as an 'Applications Engineer' I would travel from paper to paper, training personnel in how to use the terminals, run the system, etc. . . . Among others, I visited Peoria, Ill., Great Falls, Mont., and Anchorage, Alaska. However, I have forsaken all that, and am now back in Chicago, working for my father at his antique auction gallery. See what an M.I.T. education can do for you?" It can take you to some curious places!

He also sends some news of others — **Ted Moore** is at U.C.L.A., **Bob Steininger** is at U.C. Berkeley, and **Bob Fried** is married and attending medical school in Albany, N.Y. Also, **Mike McNamee** is in Indianapolis at the *Indy Star* as a Sunday Desk Editor.

I also got news of **Paul Bendt**, who is working on a Ph.D. in physics (solar energy) at the U. of Colorado. He bought 40 acres of land not too far from the University, upon which he built himself a cabin.

I also saw **Jeff Baerman** while he was visiting in Boston. He is doing fine at U. of Chicago Medical — the sight of blood no longer bothers him! Seriously, he has been working quite hard with excellent results.

Lastly, I have had a too brief chat with **Tom Openshaw**. He is now a grad student in Course XX, and is applying to medical schools. The 18 months he spent in Portugal helped him firm up his career decision. He will be a very compassionate doctor.

If I had more news, we could have longer columns. So, write letters. I love to read them. — **Arthur J. Carp**, Secretary, 67 Badger Cir., Milton, Mass. 02186

I
Civil Engineering

Saul Nuccitelli, C.E. '60, is leading Kansas City regional efforts for the M.I.T. Alumni Fund. He is currently a consulting engineer in Springfield, Mo. . . . **Harold G. Lorsch,** S.M. '42, has been appointed manager of the Energy Laboratory of the Franklin Institute Research Laboratories in Philadelphia, Penn. The Energy Laboratory is engaged in research, development and design relating to energy conservation, energy storage, and the use of unconventional energy sources such as solar energy . . . **Jim Wiesel,** S.M. '51, is a senior account executive with Merrill Lynch in Paramus, N.J.

II
Mechanical Engineering

Professor **David Gordon Wilson** has edited the most comprehensive single source of data containing the most precise information available on the properties, handling, processing, and disposal of solid waste. Called the *Handbook of Solid Waste Management,* it has just been published by Van Nostrand Reinhold, New York.

A promotion to Associate Professor of Ocean Engineering at the University of Rhode Island has been accepted by **Malcolm Spaulding,** S.M. '70 . . . **Jerry R. Wood,** S.M. '69, is currently engaged in research on compressors for the Army at Lewis Research Center . . . **Jim Masiak,** S.M. '73, is a senior project engineer involved in interior noise control of new car programs for General Motors . . . **Manuel Ratafia,** S.M. '73, is in Granville, Ohio, working on extruded plastic foams for Dow Chemicals. His wife and he are proud parents of a baby girl born early this year.

John R. Manning, Sc.D. '64, of the Stanford University faculty, has been named associate dean of the College of Engineering at Boston University, and has been appointed as associate professor in the Department of Aerospace and Mechanical Engineering there . . . **Okon M. Amana,** M.M.E. '74, has joined the General Electric Research and Development Center as a mechanical engineer . . . **Chor Huang,** Sc.D. '74, has been named research and development scientist at B. F. Goodrich Chemical Division's technical center in Avon Lake, Ohio . . . John Wiley and Sons, New York, has published *Parameter Estimation in Engineering and Science,* by **James V. Beck,** S.M. '57, and **Kenneth J. Arnold,** '36 . . . **Arant K. Nigam,** Ph.D. '71, has recently founded Horizons Research Laboratories, Inc., a privately held Florida corporation for the purpose of conducting independent research and development in medical and consumer electronics.

J. R. Manning

O. M. Amana

III
Materials Science

The College of Engineering at Iowa State University presented a Superior Teaching Award to **Frank X. Kayser,** Sc.D. '50, associate professor of materials science and engineering, at the college's opening faculty convocation. The award gives special recognition for performance as a teacher . . . **Eugene J. Michal,** Sc.D. '47, has been elected president of AMAX Extractive Research & Development, a newly-formed, wholly owned subsidiary of AMAX Inc. The new subsidiary will provide research and development services for the extraction and conversion of natural resources into marketable products.

IV
Architecture

Stan Pinska, M.Ar. '67, was recently promoted to senior associate at the New York architectural firm of Perkins and Will . . . **Richard Green,** M.C.P. '59, left his activities in 1971 as Community Development Director in Cleveland to form his own firm, Urban Dynamics. He also serves as president of a real estate management company in addition to his consulting activities.

The Building Research Advisory Board of the National Research Council has awarded **Robert B. Newman,** M.Ar. '49, a Quarter-Century Citation for his "significant and lasting contribution to the state of the art of building science and construction technology." He has served as an acoustical consultant on concert halls and has lectured and written widely on acoustics as an important aspect of the environment . . . **Albert C. Hamersky,** M.Ar. '50, has been elected President and Managing Partner of the Clark Enersen Partners, Lincoln, Neb. He joined the firm in 1952 and has been secretary of the corporation and in charge of its design department . . . **John L. Forbis,** M.Ar. '65, has been elected a Principal of the Firm at McKinsey and Company, New York, N.Y. He has recently been working with a major New York City bank on improving its customer service.

When Frederic A. L. Holloway, Sc.D. '39, ended his service on the Council of the National Academy of Engineering last spring, Courtland D. Perkins (left), President of the Academy, gave him a special token of the Academy's appreciation for his service on its governing body. But only a few weeks later, Dr. Holloway — he is Vice President, Science and Technology of Exxon Corp. — was back on the N.A.E. Council, having been elected Treasurer of the Academy. (Photo: Ankers Capitol Photographs from the N.A.E.)

V

Chemistry

At Middlebury College in Vermont, **Robert W. Gleason,** Ph.D. '60, has been named chairman of the Division of Natural Sciences. He will remain professor of chemistry and chairman of that department . . . **W. W. Schloman, Jr.,** Ph.D. '71, is currently Senior Research Chemist, Research Division, Goodyear Tire and Rubber Co., Akron, Ohio . . . **Ellen S. Switkes,** Ph.D. '72, is serving a one-year appointment as assistant to the dean of the College of Engineering at Tufts University, Medford, Mass. She is currently on a one-year sabbatical from her position as assistant professor of chemistry at the University of California at Santa Cruz, and was named a visiting Mellon Fellow under a two-year grant from the Andew W. Mellon Foundation of New York, in a program designed to broaden student and faculty perceptions of women's roles in society.

Lee M. Huber, Ph.D. '68, has been promoted within the group leader classification at Dow Chemical U.S.A., Midland, Mich. He is with the Functionalized Plastics Materials group in the Central Research Department's Plastics Laboratory . . . **Thomas C. Rounds,** Ph.D. '72, has been appointed visiting assistant professor of chemistry at the University of Denver . . . **Robert N. Nelson,** Ph.D. '69, is spending part of this year and next as a visiting assistant professor of chemistry at Colgate University.

Donald W. Shrive, Ph.D. '69, has been named recipient of the 1977 Lindback Award for "distinguished teaching" at Muhlenberg College, Allentown, Penn. He has been with the chemistry faculty there since 1969 . . . **Henry D. Simmons, Jr.,** Ph.D., '66, has just graduated with an M.D. degree from the State University of New York, Downstate Medical Center, Brooklyn, N.Y.

Rick L. Danheiser, who received his Ph.D. at Harvard in June, has joined the Department as Assistant Professor. His undergraduate degree is from Columbia, and he's a member of Phi Beta Kappa and Phi Lambda Upsilon, the honorary chemical society.

VI

Electrical Engineering

The 1977 Carlton E. Tucker Award for Excellence in Teaching has been given to **Marvin S. Keshner,** '71, and three teaching assistants in the Department of Electrical Engineering have shared the awards for excellence in teaching sponsored by Supervised Investors Trust, Inc.: **Robert R. Buckley, Robert H. Halstead, Jr.,** '75, and **Mohammad Dadashzadeh,** '75.

Dr. Wilbur B. Davenport, Jr., head of the M.I.T. Department of Electrical Engineering and Computer Science, has been appointed to a new Carnegie Commission to study the future course of public television in the United States. The 20-member commission will investigate possible effects of technological developments on public television, it will look into the economic needs of the system, and it will look into what the mission of public television should be.

Frederick W. Baumann, S.M. '34, has received General Electric Co.'s Charles P. Steinmetz Award, and he's designated M.I.T. to receive a $5,000 General Electric grant in his name as winner. The Steinmetz Awards are to recognize G.E.'s "top technical people," and $140,000 will go from G.E. to colleges and universities under the program this year. Mr. Baumann retired from General Electric early in 1977 after serving as Engineering Manager of the Small A-C Motor Department in Schenectady.

Peter J. Denning, Ph.D. '68, is currently Editor-in-Chief of *Computing Surveys,* the quarterly journal of the Association for Computing Machinery . . . **Thomas F. Weiss,** Ph.D. '59, is among 14 new Fellows elected nationally to the Acoustical Society of America. He is a member of the Communications Biophysics Group of the

J. Flanagan

M.I.T. Research Laboratory of Electronics . . . **M. Munashinghe,** E.E. '69, is an economist-engineer on the Central Projects Staff of the World Bank in Washington, D.C. . . . **C. Dale Reis,** S.M. '70, spent 14 months in Alaska developing, testing, and evaluating radar for Raytheon . . . **Nils R. Sandell, Jr.,** Ph.D. '74, has been awarded the 14th Donald P. Ecman Award by the American Automatic Control Council. He is an associate professor of system science and engineering at M.I.T. The award is presented annually by the council to a young researcher under the age of 30 for outstanding contributions in the field of automatic control.

James S. Meditch, S.M. '57, has been named Professor and Chairman of the Department of Electrical Engineering at the University of Washington, Seattle . . . The Acoustical Society of America has named **James Flanagan,** Sc.D. '50, as its president-elect. After serving a year as president-elect, he will become the society's president for a year. He is currently an engineer at Bell Laboratories, specializing in acoustics research . . . **Philip E. Serafim,** Sc.D. '60, was elected professor at the chair of theoretical and applied electrical engineering of the National Polytechnic University, Athens, Greece . . . **Richard O. Duda,** Ph.D. '62, with J. K. Aggarwal and Azriel Rosenfeld, has edited *Computer Methods in Image Analysis,* a collection of journal articles, published by IEEE Press and distributed by John Wiley and Sons, New York . . . **Louis H. Blair,** E.E. '62, has been appointed Executive Secretary of the Intergovernmental Science, Engineering and Technology Advisory Panel of the Office of Science and Technology Policy, Washington, D.C.

VI-A

Cooperative Course in Electrical Engineering and Computer Science

For some time, the VI-A Office has contemplated issuing a newsletter. Arrangements have now been made with *Technology Review* to have this become a more or less regular part of the Courses section of the *Review.* Interesting items should be forwarded to: John A. Tucker, VI-A Office; M.I.T., Room 38-473; Cambridge, Mass. 02139.

During his August business trip to the West Coast, Director John A. Tucker was feted at a pot-luck dinner hosted by **Edward C. Giaimo,** '74, of Sunnyvale, Calif. Ed is currently with Hewlett-Packard's General Systems Division in Cupertino.

Among the alumni(nae) attending were: **Peter B. Ashkin,** '73, now with H-P's Data Systems Division, Cupertino; **Wayne D. Baron,** '76, with H-P Labs in Palo Alto; **John F. Cooper,** '74, with H-P's Stanford Park Division; **John A. Edighoffer,** '73, studying for his doctorate in physics at Stanford University; **Brock C. Krizan,** '75, with H-P's Data Systems Division, Cupertino; **Susan A. Thomas,** '76, with Intel, Inc., Santa Clara; and **John D. Williams,** '76, with H-P's Data Systems Div. in Cupertino.

Current VI-A students who attended were: **Stanley D. Anderson,** '79, assigned to H-P's General Systems Division, Santa Clara; **David B. Bell,** '78, assigned to H-P's Data Systems Division, Cupertino; **Neil M. Eisman,** '78, assigned to IBM's San José Research Lab.; **William C. H. Chao,** '78, assigned to H-P's Automatic Meas-

The annual Maker of the Microphone Award memorializes Emile Berliner, inventor of the microphone and disc record; it's given every year to commemorate an outstanding contribution to the "world of sound." The 1977 winner was Cyril M. Harris, Ph.D. '45, honored for his successful acoustic redesign of Avery Fisher Hall in the Lincoln Center, New York (see February, p. A18). *The presentation was made in the concert hall itself by Oliver Berliner (left), grandson of the inventor and son of the late Edgar M. Berliner, '06. Dr. Harris, who is Professor of Electrical Engineering at Columbia University, was also responsible for the acoustic design of Washington's Kennedy Center and the new Metropolitan Opera House, New York.*

urement Division, Mountain View; and **Steven D. Krueger,** '79, assigned to H-P's Data Systems Division, Cupertino.

Mr. Tucker also travelled to Texas during his West Coast jaunt, and attended what has now become an annual VI-A Luncheon hosted by **Cecil H. Green,** '23. It was held at the Petroleum Club in downtown Dallas. All VI-A students at Texas Instruments, Inc. locations in Attleboro, Mass., and Austin, Dallas, Houston, and Lubbock, Texas, were brought to the luncheon by Texas Instruments along with their Managers.

Mr. Green chaired the informal after-dinner remarks, and said how pleased he was with the reception of the VI-A Program at Texas Instruments. Also speaking were Director Tucker, who mentioned how many, many alumni/nae have told him of the importance of the VI-A Program in their lives; Mr. George Berryman, Texas Instrument's co-ordinator of the VI-A Program; and Mr. **Joseph D. Zimmerman,** '59, Group Vice President of Texas Instruments, who expanded on Mr. Tucker's remarks as applied to his own M.I.T. experience.

During his stay in the Palo Alto area Mr. Tucker also visited the Watkins-Johnson Co. and talked with Dr. **Joel E. Schindall,** '63, Manager Recon Division, and VI-A alumnus **Kevin D. Stoddart,** '71, who is a member of their technical staff.

Two visitors to the VI-A Office on "M.I.T. Day," last June, included **Philip E. Fox,** '42, who is with IBM Corp. in Fishkill, N.Y., and Professor **Alan B. MacNee,** '42, from the University of Michigan, Ann Arbor, Mich.

Other recent visitors to the VI-A Office have included: **Barry Goldman,** '76, now attending Harvard Business School; **David S. Goldsmith,** '74, who is associated with Ivaco Rolling Mills in Ontario, Canada; **Jeffrey D. Kurtze,** '71, who's with Lincoln Laboratory and teaches at M.I.T.'s Lowell Institute School; **Andrew E. Moysenko,** '72, a Senior Engineer with Microwave Associates; **Lewis H. Rosenthal,** '73, with Motorola, Inc., in Schaumberg, Ill.; and **Jay W. Van Dwingelen,** '74, from St. Louis, Mo.

Steven L. Bates, '74, tells us he is enjoying his work with Sperry Rand Corp. in Sudbury, Mass. He and his wife are now living in a new home in Lexington, Mass. . . . **Stefania E. Calabi,** '74, sent a card from Europe where she is touring for several months. She is employed at Digital Equipment Corp. in Marlboro, Mass. . . . **Jonathan T. Frueh** '76, has joined the staff of Dynamics Research Corp. in Wilmington, Mass. . . . **Sherry R. Grobstein,** '74, had an article published in the September, 1977 issue of the *Hewlett-Packard Journal.* Sherry is with the Waltham Division of Hewlett-Packard's Medical Products Group. After hours she is spending time remodeling a house of 1840 vintage which she purchased in Lexington, Mass.

Returning to the M.I.T. campus for doctoral work is **R. Duff McRoberts,** '72. Duff has been employed by the Hewlett-Packard Co. at their Loveland, Colo., division. . . . **David E. Meharry,** '70, who spent some years in Finland earning a doctorate from the University of Helsinki, has returned with his family to the U.S. and become employed by Microwave Associates, Inc. in Burlington, Mass. . . . **Eric A. Slutz,** '74, who is employed at H-P Labs in Palo Alto, has taken leave this fall to attend Stanford University to complete his work for his doctorate. . . . **Norman D. Wittels,** '69, is now with Sperry Rand in Sudbury, Mass., following a period with IBM's Watson Laboratory in Yorktown Heights, N.Y. Norm spent three months in the Soviet Union as a Visiting Scientist. His wife, **Jill J. Wittels,** '70, accompanied him; she is a Research Associate in M.I.T.'s Department of Earth and Planetary Science.

It is with sadness that we note the untimely death on October 4, 1977, of **Peter S. Haase** '76. Peter was a VI-A student who was completing his Graduate Work Assignments at Hewlett-Packard's Electronics Research Laboratory in Palo Alto, Calif. Our deepest sympathy is extended to his family and friends.

VIII
Physics

Kenneth N. Stevens, Sc.D. '52, Professor of Electrical and Bioengineering at M.I.T., completed his term as President of the Acoustical Society of America during the Society's annual meeting at Pennsylvania State University in June; he'll be succeeded in a year by James L. Flanagan, Sc.D. '55, Head of the Acoustics Research Department at Bell Laboratories, who was named President-Elect of A.S.A.

Douglas M. Van Patter, Ph.D. '49, has moved to the University of Delaware, Newark, Del. He had been Professor and Senior Physicist at the Bartol Research Foundation . . . **Charles Naiman,** Ph.D. '61, has been appointed Director of Laser Metalworking at Avco Everett Research Laboratory, Inc., Everett, Mass.

Andrea A. diSessa, Ph.D. '75, has been promoted from Special Lecturer to Assistant Professor in the Division for Study and Research in Education at M.I.T. In D.S.R.E. since 1975, he's seeking more intuitive and learnable ways of presenting mathematics and physics in high school and undergraduate university classes; during the past two summers he's worked in a special program for high-ability high school students in mathematics, physics, and computer science.

Dr. diSessa will continue as a member of the M.I.T. Artificial Intelligence Laboratory.

R. O. Baukol

R. L. Mitchell

D. W. Ryckman

R. S. Engelbrecht

Energy, Fisheries in New England

Grants for two new programs in the Department of Urban Studies and Planning announced during the summer:

☐ A $10,000 grant from the Gorton Group of Gloucester, Mass., provides a fellowship for the study of New England fisheries; it's to be part of the Department's ongoing research on New England economic development.

☐ Problems in siting energy facilities in New England will be studied under a new grant from the Energy Research and Development Administration; it's a continuation of work on the effects of new energy facilities under way for the past two years for E.R.D.A. in the Laboratory of Architecture and Planning.

Pressman Fellowship

A fellowship in memory of the late Jeffrey L. Pressman, Associate Professor of Political Science, has been funded by the M.I.T.-Harvard Joint Center for Urban Studies, and its first recipient — Martin Sánchez-Jankowski, a graduate student in political science — will use its funds to complete his thesis on the cultural and political values of Chicano adolescents in American cities.

Professor Arthur P. Solomon, Director of the Joint Center, says Professor Pressman was "an outstanding colleague whose brilliant scholarship was matched by his constant concern for the intellectual and personal development of his students."

X
Chemical Engineering

Robert C. Armstrong, assistant professor in the M.I.T. Department of Chemical Engineering, has collaborated recently on texts published by John Wiley and Sons, Inc., New York. *Dynamics of Polymeric Liquids, Vol. 1: Fluid Mechanics* and *Vol. 2: Kinetics Theory* discuss the experimental data and molecular theories which describe polymer solutions and melts.

James McNeely, S.M. '57, has recently accepted the position of manager, Crystal Product Department, Materials Research Center, Allied Chemical Corporation, Morristown, N.J.

Ronald O. Baukol, S.M. '60, has been named manager of a new Diagnostic Products Department within 3M Company's Medical Products Division. The Diagnostic Products Department will manufacture and market such products as stethoscopes, ECG systems, monitoring electrodes, clinical laboratory products, and nuclear medical products . . . Celanese Corp. has elected **Robert L. Mitchell,** S.M. '47, as a member of its Board of Directors. He joined the Celanese organization in 1947 as a chemical engineer, and most recently has been executive vice president of the worldwide chemicals, plastics, and polymer specialties group of the company . . . **Maurice Kunstenaar,** S.M. '50, has updated the information on him from the 1960s when he was assistant manager of Sinclair Petrochemicals' International Division. Since then, he has been with Chemical Construction Corp. as senior consultant, acting manager of the consulting division, and sales manager. In late 1974, Maurice joined Stone and Webster Engineering Corporation as manager, chemicals/petrochemicals, process technology, and economics division.

XI
Urban Studies

Hubert E. Jones, associate professor of urban studies and planning and head of M.I.T.'s Community Fellows Program, has left the Institute to become dean of Boston University's School of Social Work.

D. W. Ryckman, Sc.D. '56, has accepted an appointment as Chairman of the Regional Commerce and Growth Association's Environmental Committee in St. Louis, Missouri. He is currently President of REACT (Ryckman's Emergency Action Consulting Team), environmental scientists and engineers specializing in emergency pollution response and clean-up operations . . . President of the Water Pollution Control Federation is **Richard S. Engelbrecht,** Sc.D. '52, who is currently serving as Commissioner from Illinois on the Ohio River Valley Water Sanitation Commission.

Ben Rosenbloom, M.C.P. '74, is a city planner for the City of Los Angeles. He is working on a Downtown People Mover and a Redevelopment Project for the downtown . . . **Langley C. Keyes, Jr.,** Ph.D. '67, has been elected a Director of the Associated Harvard Alumni . . . **Lawrence R. Susskind,** Ph.D. '73, has been reappointed a member of the Metropolitan Area Planning Council of Greater Boston. The M.A.P.C. drafts plans to meet the region's future needs in the areas of housing, land use, open space, recreation, transportation and environmental protection.

XIII
Ocean Engineering

Malcolm E. Clark, N.E. '54, has taken over the post of superintendent at the Coast Guard Academy, New London, Conn. . . . **William Dubbs,** O.E. '74, left the Navy in June, 1977, and will be Senior Project Engineer for the Lummus Company, a division of Combustion Engineering, Inc., in Houston, Tex. At the same time, the Power Systems Group of Combustion Engineering has appointed **John H. Randall,** S.M. '48, as director of construction services sales. . . . General Dynamics, Quincy Shipbuilding Division, recently announced that **Spencer Reitz,** S.M. '48, was named Director of Naval Programs . . . **William D. Grant,** Sc.D. '77, has joined the Woods Hole Oceanographic Institution as a member of its ocean engineering department. His research interests include nearshore and coastal processes, wave and current interaction, sediment transport, and beach erosion.

Fendall Marbury, Jr., Ph.D. '68, is studying energy consumption by river shipping, together with the related subject of line-haul economy; objectives are to learn how to minimize the consumption per ton-mile of either fuel or money . . . **Arthur P. Amesse,** N.E. '67, is the engineering services officer at the Naval Research Laboratory, Washington, D.C. . . . **Michael F. Vetter,** S.M. '71, has arrived for duty at Hanscom Air Force Base, Mass. He is a development engineer with a unit of the Air Force Systems Command.

XIV
Economics

David R. Wheeler, Ph.D. '74, received the Metcalf Award of $1,000, one of Boston University's highest awards for excellence in teaching. He is an assistant professor of Economics and African Studies at the University, and as a member of the College of Liberal Arts faculty, was recognized for "his innovative approach to teaching" the difficult subjects of econometrics, microeconomic theory and economic policy in developing countries. The citation read in part, "None of these subjects is obviously glamorous or intellectually relaxing. Yet his teaching in all these areas is a superb example

of how difficult mathematical techniques can be used to illuminate rather than to obscure economic reality . . . students at every level comment that he is the best professor they have ever had."

At M.I.T.'s Sloan School of Management, **Martin B. Zimmerman,** Ph.D. '68, has been promoted from lecturer to assistant professor of management, for a three-year period starting with the current school term. He is also a member of the Federal Energy Administration's Environmental Advisory Committee.

XV
Management

The M.I.T. Press has just published *Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information Within the R & D Organization,* by **Thomas J. Allen,** Ph.D. '66. The book gives a comprehensive view of the management of technical information and shows how actual information-flow patterns can be used to improve communication among technologists . . . **Bernall K. Stone,** Ph.D. '69, is the Mills B. Lane Professor of Banking and Finance at Georgia Tech . . . **Leslie Clift Hruby,** S.M. '73, has become the Materials Manager for the Deng, N.H., plant of the Digital Equipment Corp . . . **Chi-Yuan Lin,** Ph.D. '68, has been appointed as the Director of the Doctoral Program, Graduate School of Business Administration at the University of Southern California . . . The Family Motor Coach Association has elected **John R. Morris,** S.M. '57, as its president. The Association promotes and serves the interests of families involved in motor coach recreation .

Gillett Welles III, S.M. '63, has been appointed director of manufacturing and engineering — Europe, at Corning Glass Works, Corning, New York . . . **S. Allen Heininger,** S.E. '69, has been elected a Vice President — Research and Development, of the Monsanto Company, St. Louis, Missouri. He will head the Corporate Research and Development Staff . . . **Bernard Kupferschmid,** S.M. '56, was recently elected a Principal at Harbridge House in Boston, where he directs their Latin American consulting activities. He specializes in the research, conceptualization, design, and presentation of management education programs in a multinational environment. . . **Henry B. Barg,** S.M. '73, has been named director of the Annual Fund at Tufts University in Medford, Mass. He will be coordinating the fundraising programs at the Medford campus . . . **Paul A. Strassman,** S.M. '55, is currently Director — Administration and Systems, Xerox Corporation. He recently spoke at the International Data Corporation's Executive Conference on "Information Networks — Tomorrow's Office."

XVI
Aeronautics and Astronautics

James W. Clark, S.M. '57, has been appointed manager of the engineering operations department at United Technologies Research Center, East Hartford, Conn. . . **Peter Bainum,** S.M. '60, was recently elected vice president — publications of the American Astronautical Society, and he has been appointed to the Astrodynamics technical committee of the American Institute of Aeronautics and Astronautics. He is a graduate professor of aerospace engineering at Howard University . . . **Abner B. Martin,** S.M. '54, is the man who managed the Air Force's B-1 strategic bomber program for nearly four years. He has been nominated for promotion to lieutenent general, and will be promoted following confirmation by the Senate . . . **Herman P. Schutten,** S.M. '64, has been named director of advanced concepts for Logic Device and Systems of Cutler-Hammer, Inc., a Milwaukee-based electrical/electronics firm. In this post, he will be responsible for application of advance technology to new product developments.

XVII
Political Science

William H. Matthews, Ph.D. '70, has been appointed the first director of the East-West Environment and Policy Institute to be established at the East-West Center in Honolulu, Hawaii. He has been closely associated with the United Nations Environment Programs for several years. The new Institute's program is being designed to promote better understanding and relations among East and West nations through cooperative efforts to generate new knowledge and organize mutual learning about policy of all types affecting the environment . . . **Russell Betts,** Ph.D. '76, has transferred to Indonesia in order to assume responsibility as The Asia Foundation's resident representative in that country.

Professor **Robert I. Rotberg** has been elected chairman of the nominating committee of the American Historical Association, the world's largest academic professional organization in the humanities and social sciences. He is also one of the authors of the recently-published *The Black Homelands of South Africa,* a book exposing aspects of South Africa's racially divisive program of separate development, part of a special series on southern Africa published by the University of California Press . . . *The Social Impact of the Telephone* has just been published by the M.I.T. Press. Edited by Professor **Ithiel de Sola Pool,** the book is a collection of essays derived from a series of seminars conducted at M.I.T. in 1976 in conjunction with the centennial of the telephone. **Russell H. Betts,** Ph.D. '75, has been assigned as The Asia Foundation's resident representative to Indonesia.

XXII
Nuclear Engineering

Mujid S. Kazimi, Ph.D. '73, has been appointed assistant professor in the Department; his fields of interest are nuclear reactor safety analysis, nuclear reactor design and optimization heat transfer, fluid mechanics in two-phase media, and scientific advancement and technology transfer in developing countries.

Edward E. Pilat, Ph.D. '67, has been appointed Vice President of Research for the Energy Research Group, Inc., Framingham, Mass . . . **William T. McCormick, Jr.,** Ph.D. '69, has been elected by the Board of Directors of the American Gas Association to the office of Vice President for Planning and Analysis. He had previously been Director of the Office of Commercialization of the U.S. Energy Research and Development Administration . . . **Wesley K. Foell,** S.M. '59, is currently director of the Energy Systems and Policy Research Group at the University of Wisconsin College of Engineering and Institute for Environmental Studies.

Henri Fenech, Ph.D. '59, has been elected a Fellow of the American Nuclear Society.

XXIII
Linguistics

Two professors of linguistics in the Department of Linguistics and Philosophy at M.I.T. were named recipients of 1977-78 Guggenheim Fellowship awards for their research and work. **David M. Perlmutter,** Ph.D. '68, an associate professor of linguistics, will do research locally on rational grammar; **John Robert Ross,** Ph.D. '67, a professor of linguistics, will study semantics, syntax and phonetics primarily at M.I.T. and in West Berlin . . . **Barbara Hall Partee,** Ph.D. '65, was a 1976-77 Fellow at the Center for Advanced Study in the Behavioral Sciences, Stanford, Calif.

A. A. Altshuler

Alan A. Altshuler, Transportation Expert, Heads Political Science

Professor Alan A. Altshuler, who returned to the M.I.T. faculty in 1975 after four years as Massachusetts' Secretary of Transportation and Construction, is now Head of the Department of Political Science. He succeeds Professor Myron Weiner, who is returning to full-time teaching and research in the Department.

Dr. Altshuler's career in public policymaking for transportation began when Governor Francis W. Sargent, '39, made him Chairman of a special Task Force on Transportation in 1969; it was on the advice of this group that Governor Sargent in 1970 halted expressway construction in the Greater Boston area and ordered a comprehensive planning effort for eastern Massachusetts transportation. Dr. Altshuler then served as Director of this Boston Transportation Planning Review until he joined the Governor's cabinet in 1971, and he continued to be identified with that project's new plan emphasizing mass transit instead of highway development for the region.

Dr. Altshuler is now completing a book on politics, innovation, and urban transportation policy; earlier books have been on city planning processes and community control of urban affairs. He came to M.I.T. in 1966 as Associate Professor of Political Science after teaching assignments at Swarthmore and Cornell, where he studied for his bachelor's degree (1957). His graduate degrees in political science (M.A. 1959, Ph.D. 1961) are from the University of Chicago.

People

J. Holt

James Holt, 1897-1977; 42 Years a Pillar of Mechanical Engineering

James Holt, '19, who taught mechanical engineering at M.I.T. from 1920 until his retirement in 1962, died on August 22 at a nursing home in Plymouth, Mass.; he was 80.

A specialist in heat engineering, Professor Holt joined the M.I.T. faculty as Assistant Professor in 1927, having served as instructor in the Department almost since he received his degree from Harvard and M.I.T. He became Executive Officer in 1946 and served in this capacity until his retirement, being briefly in 1954 and 1955 Acting Head.

Professor Holt was past President of the Massachusetts Chapter of the American Society of Heating and Ventilating Engineers and of the Engineering Societies of New England; he was a former Chairman of the Boston Section of the American Society of Mechanical Engineers, a member of the American Institute of Consulting Engineers, and active in Pi Tau Sigma and Sigma Xi.

Melvin L. Cabral, 1935-1977

Melvin L. Cabral, Administrative Officer of the Department of Civil Engineering, died of heart failure on August 29; he was 42.

Mr. Cabral came to M.I.T. in 1953 to work in the Instrumentation Laboratory. He joined the National Magnet Laboratory in 1961, Project MAC in 1964, and the Department of Civil Engineering in 1969 as Business Manager for Project CARS. He was promoted to Administrative Officer in 1970.

Dale Runge, 1934-1977

Dale Runge, Ph.D. '76, Assistant Professor of Management, was found dead on September 2 in Building E40, where he worked with the Sloan School's System Dynamics Group; his death was ruled a suicide.

Dr. Runge came to M.I.T. in 1965 after receiving degrees in engineering (B.A. 1964, B.M.E. 1965) from Dartmouth College. While studying for his advanced degree, Dr. Runge lectured and conducted workshops in System Dynamics; and he continued teaching in this field as a member of the faculty beginning in 1976. He also had taught at Santa Maria Technical University in Valparaiso, Chile, and worked as development engineer at the School of Engineering of the University of California in Los Angeles; he was Research Associate for the Automobile Club of Southern California.

Dr. Runge was in charge of the labor section of the System Dynamics National Model under Professor Jay W. Forrester.

Deceased

Paul L. Cumings, '07; June 20, 1977; 770 Boylston St., Apt. 11F, Boston, Mass.
Roger C. Rice, '08; August 12, 1977; Los Banos Convalescent Hosp., Los Banos, Calif.
Capt. James O. Gawne, '10; October 22, 1976; 3133 Conn. Ave. N.W., Washington, D.C.
Charles W. Nitschke, '11; March 11, 1973
Howard D. Williams, '11; September 28, 1977; 10375 Wilshire Blvd., Apt. 12A, Los Angeles, Calif.
Charles L. Coroles, '14; August 18, 1977; 331 No. Main St., New York, N.Y.
Earl H. Townsend, '16; September 8, 1977; 66 Newton St., Waltham, Mass.
Francis Goodale, '17; August 18, 1977; Box 100, Rd. 4, Stroudsburg, Penn.
Frank E. McKane, '17; June 23, 1977; 200 Silver Dr., Dover, N.H.
George S. Brewer, '18; September 16, 1977; 1216 West Ninth St., Erie, Penn.
James Holt, '19; August 22, 1977; Snug Harbor, Bx. 81, Duxbury, Mass.
Franklin H. Blackmer, '20; September 8, 1977; 928 Middle St., Bath, Maine
Harry I. Granger, '20; August 10, 1977
J. Morton Briggs, '21; July 27, 1977; 221 Smith Neck Rd., So. Dartmouth, Mass.
Robert J. Ballentine, '22; January 21, 1977; 209 E. Madison Ave., Wheaton, Ill.
Richard J. Bard, '22; May 30, 1977; Poundridge Road, Bedford, N.Y.
Kenneth Bernard, '22; March 20, 1977; 1807 Key Blvd., Arlington, Va.
Yoshinori Chatani, '22; July 19, 1977; 5-18 Sakuragaoka, 5 Chome Setagaya-ku, Tokyo, Japan.
Erb N. Ditton, '22; June 20, 1977; P.O. Box 51, Quechee, Vt.
William D. Pinkham, '22; June 1, 1975; 438

East Bridge St., Granbury, Texas
Bernard M. Rivkin, '22; August 15, 1977; 295 Fairmount Ave., Hyde Park, Mass.
Carl D. Dippel, '23; September 1, 1976; 6238 Highgate, Dallas, Texas
Col. Clark Kittrell, '23; January 26, 1977; 1794 York Ave., Memphis, Tenn.
John H. Little, '23; April 10, 1977; 50 Harborview Ln. #27, Belleair Bluffs, Fla.
Capt. Carl F. Muckenhaupt, '24; August 19, 1977; 332 Winchester St., Newton Highlands, Mass.
Bernard E. Groenewold, '25; 435 Gulfstream Ave., Apt. 205, Sarasota, Fla.
Norman L. Mansfield, '25; June, 1977; 12 Cambridge Rd., Glen Ridge, N.J.
Ralph B. Norton, '25; April 8, 1977; Whittemore Point R.F.D., Buzzards Bay, Mass.
Lebaron C. Colt, '26; June 23, 1976; 31 Mt. Vernon St., Boston, Mass.
John D. Eldert, '27; August 18, 1977; 16 Chapman Ln., Barrington, R.I.
Howard P. Ferguson, '27; August 13, 1977; 470 Stepp Ave., Hendersonville, N.C.
Herbert M. Houghton, '27; August 9, 1977; 3428 Forest Ave., Medford, Ohio
Dudley F. Collier, '28; August 22, 1977; 28 Pont St., Bx. 13, Billerica, Mass.
Mary W. Manley, '28; June 20, 1977; 310 W. Washington Ave., Elmira, N.Y.
W. Spencer Hutchinson, Jr., '29; June 8, 1977; 2892 Orchard Ave., Grand Junction, Colo.
John L. Dodson, '31; July 2, 1970; R.D. 4, Montpelier, Vt.
Charles Straley, '31; September 1, 1977; 2807 Settle Rd., Mariemont, Cincinnati, Ohio
H. Archer Clark, Jr., '32; August, 1977; 71 Waterside Ln., West Hartford, Conn.
Joseph E. Coffey, Jr., '32; July 3, 1974; Box 2, Greenbush, Mass.
William F. Spreen, Jr., '32; September 19, 1977; 4197 Sentinel Post Rd., Atlanta, Ga.
Wolfgang M. Kloenne, '33; June 7, 1975; 21 Penhurst Ave., Essexwold, Bedfordview, 2008, South Africa
Edward D. Rohn, '33; November 26, 1976; 4612 Del Mar Ave., San Diego, Calif.
Leonard P. Cohen, '36; August 8, 1977; 802 La Salina Pl., Oceanside, Calif.
Charles W. Freeman, '40; May 1, 1977; 9 Nicholas Brown Yard Rd., Providence, R.I.
M. Bryce Leggett, '40; August 13, 1977; 25 Apple Hill Ln., Lynnfield, Mass.
Dr. John R. Pellam, '40; July 23, 1977; 124 Via Lorca, Newport Beach, Calif.
Capt. Lewis A. Rupp, '43; September 30, 1977; 4117 Druid Hills Dr., #218, Dallas, Texas
Arthur D. Saul, Jr., '44; August, 1977; 24 Gray St., Arlington, Mass.
Diran C. Basmajian, '50; September 2, 1977; 152 Linden Dr., Cohasset, Mass.
Robert C. K. Au, '55; August 28, 1977; 4659 Club Cir. N.E., Atlanta, Ga.
Rollo D. Zug, '57; June 30, 1971; 3540 Churchville Rd., Aberdeen, Md.
Michael J. Murray III, '64; July 4, 1977; 185 Harrison St., Princeton, N.J.
Craig W. Johnson, '72; June 8, 1977; Royal College of Art, London, England

The M.I.T. Club of Mexico announces the 30th annual Fiesta Guanajuato, Mexico March 9 through 12, 1978

For further information, write William M. Collins, '65, Apt. 101, Monte Chimborazo 621, Mexico 10, D.F., Mexico

Report of the President and the Chancellor

For the Academic Year 1976-77
Massachusetts Institute of Technology

INTRODUCTION: A LEADERSHIP ROLE

M.I.T. has always sought to exert leadership in its chosen fields, where it possesses unique strengths. Among the characteristics and resources that make this leadership role possible are M.I.T.'s spirit of innovation, its continuing commitment to addressing major technical and social problems of the day, the outstanding quality of its faculty and student body, the strong and substantive faculty and student linkages with government and industry, and the extraordinary dedication of M.I.T.'s friends and alumni. All of these encourage an independence which allows the Institute to act in most instances according to its own best judgment in a complex and increasingly constrained world. M.I.T. has been able, to a considerable degree, to select its own objectives and style, to create new ways to look at familiar problems, to understand and help solve new problems and, by embedding the education of students in the research enterprise, to provide a unique intellectual context to stimulate the minds of its students.

As we review the events of the past year we see many of those events as steps in the continuous evolution of M.I.T.'s educational programs and research priorities in response to emerging societal problems. We also note the emergence at M.I.T. of new organizational forms to foster educational and research efforts that transcend the boundaries of departments and schools. Academic disciplines, professions, and the educational programs related to both, go through periodic cycles of advancement and growth stimulated by challenging new discoveries, new organizing concepts, the availability of new technologies, and new social concerns. Such surges in a field are accompanied by rapid increases in student enrollments, research support, and the gravitation of researchers toward the new and exciting set of ideas. A university such as M.I.T. is a culture for such fields — each at a different stage in the development of powerful new levels of understanding. In science, engineering, management, architecture, planning, the social sciences, and the humanities there is a continuous flow of new problems and of new efforts to understand and to solve them. The intellectual questions which most stimulate many M.I.T. faculty members and students are, increasingly, questions which require the collaboration of scholars from more than one discipline. Therefore, throughout the Institute there exists the need to find support for emerging new kinds of research, the need to invent new organizational forms which fit the new goals, and the need to articulate all of this with the educational program and continually to assess the adequacy of this program in a changing intellectual and social world. These are issues which have preoccupied many at M.I.T. in recent years and will continue to require much attention in the future.

While we have sought to maintain the intellectual vigor of M.I.T.'s departments and research centers and to provide resources and encouragement for their continued evolution and renewal, we have also been concerned to broaden and deepen the financial base on which M.I.T. rests. Thus it gives us considerable satisfaction to note that the Leadership Campaign has passed the half-way point toward the goal of $225 million. At the same time we realize that the hardest half of the Campaign is ahead of us, and we are prepared to redouble our efforts to meet the ultimate goal. We are also pleased to report that M.I.T. was able to operate with an essentially balanced budget during the past year, due not only to increased revenues from the Campaign and other sources, but equally to the effective cost-control measures exercised during the past five years. Fiscal problems have demanded much administrative energy during the last five years and obviously must continue to do so. Fund raising and ensuring effective use of available funds are critical to the survival of M.I.T. as a high-quality private institution.

In this Report we will discuss a number of issues concerning the kind of education M.I.T. provides for its undergraduates, the ways in which the evolution of educational and research programs reflect major contemporary concerns in our society, the several new organizational forms which are developing at M.I.T. to support work which faculty members and students want to do, and the way in which all of these intersect with the need to maintain the financial strength of the Institute.

ISSUES IN UNDERGRADUATE EDUCATION

Undergraduate education is a primary mission of the Institute and an essential part of the close partnership between education and research that is the Institute's most distinctive and characteristic feature. From time to time in these Reports, we have noted significant developments and directions in undergraduate education at M.I.T. We have commented on the range of student interests and the diversity of the Institute's formal programs; on the recruitment, support, and contributions of minority students and women students; on the Institute's desire to increase the relevance of its educational experience to the fundamental societal problems of our time and to the eventual solution of those problems; and on the increasingly central part that direct research experience for students plays in the Institute's undergraduate programs. In all these respects, and in others as well, one may note the continuing emergence of the Institute as a major university in the fullest and broadest sense of Dr. James R. Killian, Jr.'s prescriptive phrase, "a university polarized around science, technology, and the arts."

Undergraduate education at M.I.T., with its balance of science, technology, social concerns, and humanistic studies, continues to be popular among the most talented young people in our nation; the Class of 1981 is larger than planned at 1,080 members. The policy of modest increases in class size, which we have been implementing during the past few years, is now straining the capacity of the housing system and creating serious shortages of financial aid. There are more

students who are qualified to come to M.I.T., who want to come, and whom we could responsibly educate, than we can house or for whom we can provide needed financial aid. These two needs will receive special attention during the second half of the Campaign. Furthermore, once here, undergraduates select their field of concentration according to their own interests, and in recent years we have noted resurgent interest in the various fields of engineering. This interest continues to grow — last year 63 percent of all "designated" second-year students were enrolled in the School of Engineering, a continuation of a pattern which showed 45 percent in 1974-75 and 55 percent in 1975-76. Such large shifts in undergraduate enrollment, particularly into the Departments of Chemical Engineering, Electrical Engineering and Computer Science, and Mechanical Engineering, combined with budget reductions taken as part of our Institute-wide cost control efforts over the past five years, have produced stresses which must be relieved.

While increases and shifts in enrollment create a variety of such strains, they equally attest to the high regard with which an M.I.T. education is held by the world at large, and they remind us of our obligation to ensure that an M.I.T. education is the best of its kind. During a period of increasing concern about the goals and forms of undergraduate education in colleges and universities throughout the nation, M.I.T. faculty members have continued to demonstrate their own deep commitment to undergraduate education, and we believe that a new look at these questions of goals and forms will be a major part of faculty discussion and planning in the next several years.

The Institute's undergraduate programs are distinctive among those of comparable universities in that they are professionally oriented in format. At the same time, the faculty has developed and instituted a set of requirements for breadth and diversity within each student's program, so that an M.I.T. undergraduate program may be a truly liberal education. In this Report, we turn to three fundamental aspects of our undergraduate programs. The first concerns the extent and form in which the Institute provides an introduction to the basic natural sciences and the adequacy of this introduction as a foundation for upperclass departmental work. The second concerns the way in which the Institute requires, or provides opportunities for, undergraduate work in the humanities, arts, and social sciences. This issue is of keen interest because M.I.T. has always sought to incorporate a significant humanistic component in its undergraduate education and the desire for this has grown stronger in recent years as the interactions between science, technology, and the society have become more intense and controversial. The third concerns the form and content of undergraduate engineering education, which has been the subject of intense review by the Committee on Engineering Education of the School of Engineering, a study group that has been functioning for the past two years.

I

The Institute's undergraduate degree requirements include a required year of elementary calculus, a year of physics, and a half-year of chemistry or biology. These constitute the "science core requirement," and the subjects satisfying this requirement are normally taken in the freshman year. In addition, students must satisfy a three-subject science distribution requirement; a laboratory requirement; a set of humanities, arts, and social sciences requirements; the program requirements of their majors; and a physical education requirement. (It is interesting to note that the combined science core, science distribution, and laboratory requirement are the equivalent of a science major at most universities.) It is the "science core" which concerns us here, and its evolution over the years in response to a changing intellectual world.

In the years immediately following World War II, and in the light of the Report (now nearly 30 years old) of the Committee on Educational Survey, the faculty reformulated the previous science core requirement for all undergraduates to include four terms of mathematics, four terms of physics, and two terms of chemistry, to be taken in the first and second years. Specific subjects to satisfy the requirement were offered by each of the three departments. The Committee had noted M.I.T.'s prior history of rigidly prescribed educational programs and was striving toward somewhat more flexibility in order best to develop the talents of its students. Nonetheless, the programs of freshmen and sophomores remained largely uniform, and this helped to provide a sense of common educational experience and purpose among first and second year students.

The science core requirement of the 1950s was established in the belief that all undergraduates should have a serious professional introduction to the basic sciences, that this introduction should be taught by professionals in those sciences, that determination of content should largely rest with those professionals, but that, at the same time, the core subjects should represent a reasonably well-planned common body of scientific knowledge and skills upon which upperclass departmental programs could later rely and draw.

Early in the 1960s, after the Sputnik shock, pressures of two kinds led to a reexamination and revision of the science core requirement. First, increasing numbers of freshmen had, in high school, gone more deeply than before into significant portions of the M.I.T. core material. Second, the faculty increasingly came to believe that a larger amount of choice, through which students could obtain programs more closely fitted to their individual backgrounds and interests, would be educationally desirable. The Committee on Curriculum Content Planning, established by President Julius A. Stratton, recommended in 1964 that the amount of common core time in all three departments be reduced by 50 percent, and that some of the time thereby gained in a student's schedule be assigned to a new Science Distribution Requirement. This recommendation was adopted by the faculty, and the general structure of the core requirement has remained unchanged since that time.

During the past decade, the faculty has introduced certain additional options within the science core. The student may choose either of two one-year sequences for the year of mathematics, and any of four one-year sequences for the year of physics. The differences in content among these alternative sequences are less than might at first appear. Both mathematics sequences cover elementary calculus and elementary vector analysis. All physics sequences cover mechanics in the first term and electricity and magnetism in the second term. The differences that do exist among alternatives are differences of choice and emphasis in illustrative examples and, to some extent, differences of intellectual and teaching styles. The required term of chemistry, on the other hand, has evolved into a required term of chemistry or biology, and five distinct alternatives have been designated by the faculty. These include: a subject in elementary chemical structure and bonding, a subject in structure and bonding emphasizing organic chemistry, a subject in physical chemistry, a subject in chemical structure emphasizing the solid state and taught by the Department of Materials Science and Engineering, and a subject in basic biology taught by the Department of Biology.

The functions of the science core in a student's undergraduate program are several. First, the science core provides a common body of knowledge and methods, and a level of proficiency in them, that can be assumed by all departments for upperclass work. Most undergraduate degrees from M.I.T. specify a professional field, and departments in the Schools of Engineering and Science have justified this specification in part on the basis that the degree represents a coherent four-year program in the specified field, of which the science core is the foundation. At the same time, the present articulation between the science core and the possible upperclass departmental majors permits the student a full range of choices among possible majors at the end of the freshman year. The student is not forced to make this choice at the time of entering M.I.T.

Second, in addition to serving as a form of prerequisite for later work, each subject in the science core provides an introduction, in its own right, to its own disciplinary area. The argument that substantive knowledge of each of these areas is an essential part of an education for today's and tomorrow's world is strong.

Third, the core subjects emphasize creative analytical ability of a high order. For example, passage through the physics subjects, even for some of our most talented undergraduates, is not always easy. The challenge of analyzing and solving a complex "word problem," of developing a sense of the potential intersection and interaction of theoretical concept and practical reality, and of developing a confidence in one's own powers for such analysis, is difficult but ultimately valuable and instructive. This is perhaps best summed up in the proud observation of many graduates that "M.I.T. taught me how to think."

Not everyone agrees that the science core, in principle or in detail, is desirable. Some argue that the core subjects represent a significant and somewhat arbitrary hurdle in the undergraduate curriculum that may discourage talented students from coming to M.I.T. and from contributing to the richness and variety that should characterize a great university. They go on to argue that there are forms of thought and sensibility that are creative, demanding, and valuable, but are unrelated to the concepts and methods of the natural sciences as presented in the core. They observe that some departmental programs outside of engineering and science do not need the subject matter of the core as a prerequisite. Finally, some would take the further position that the analytical abilities emphasized in the core are not easily transferable to disciplines outside of the natural sciences and engineering.

Some others at the Institute hold that the science core has shrunk too much and that its reduction by half in 1964 was mistaken. They believe that the educational benefits of the core would be enhanced by enlarging it and that, moreover, the identification of M.I.T. with depth and strength in science and technology, which they believe to be of great value to the Institute and to society, was weakened by the 1964 modifications.

Still others are concerned that the achievements and abilities of students entering the upperclass departmental programs appear to be more uneven than before. This leads to concern for ways in which the core subjects in the freshman year could better recognize and remedy the deficiencies in skill and prior preparation. It also leads to more general questions concerning the better identification of abilities and disabilities among entering students, the difference in educational style and context between secondary school and university, and the variety of learning styles that students may bring to their work at M.I.T.

We expect that the status and content of the science core will be a subject of faculty deliberation during the next several years. While we do not know what the outcome of such discussions will be, we do not anticipate that a reduction in the size of the present science core will occur or that a change in its standard of difficulty will be recommended. We expect, rather, that possible and desirable changes in content and emphasis within the science core subjects will be a principal object of discussion and that much of that discussion will be focused in the relevant departments. Issues of content may include the following: Do the present core subjects place too much emphasis on getting a single correct numerical answer rather than on the qualitative solutions and approximation bounds that are more characteristic of scientific and engineering applications? Do the core subjects adequately recognize the role and power of computers in current science and engineering? Are the present core subjects, especially in mathematics and physics, justified in emphasizing continuous and deterministic concepts and methods in the spirit of Newton and Euler at the expense of the often more discrete and statistical concepts of 20th Century science? Can one emphasize the latter in introductory subjects without at the same time sacrificing a significant measure of internal coherence and hence of educational value? Can one make such changes and maintain the paradigm of hard and creative analysis that the present subjects appear to present? Is the current core material a necessary prerequisite to a proper and sensitive understanding of more recent concepts and methods? We

believe that the Institute will look forward with the liveliest interest to these discussions and to their outcome.

II

We turn next to the question of the manner and extent to which the Institute can provide a truly liberal education for its undergraduate students. We believe that for M.I.T., such an education should ideally have four characteristics. First, it should provide a capability for careful intellectual analysis and creative intellectual effort, both qualitative and quantitative, with a recognition of the power of new concepts and insights to make such analysis and such effort fruitful. Second, it should develop the capacity for intellectual self-renewal, so that students can continue to learn and to cope with new problems. Third, it should encourage and help to provide a personal, social, and cultural breadth that enables students better to relate to and understand their society, their world, and their past. Fourth, it should provide through knowledge, example, and encouragement, a basis upon which students may best build and maintain personal integrity and a sense of commitment to their highest personal values. We believe that M.I.T. students should find some elements of these qualities in every area of study — science, technology, social science, humanities, and the arts.

Science and technology have been criticized for their lack of concern with values, and it is sometimes alleged that this lack of concern on the part of scientists and engineers has been a cause of current environmental, economic, and social problems. We do not accept this view. Science and technology have always had a strong relationship to, and indeed been a manifestation of, the values — and often the best values — of the society and culture in which they find themselves. We believe that in the 116 years of its existence M.I.T. has been extraordinarily successful in training its students for roles of leadership and service in our society, and that it has done so in accord with the highest hopes and aspirations of its time. The problem today is not that science and technology have been separated from questions of value, but that the problems which our society faces have become more complex and contemporary values more pluralistic. The challenge that we face is one of matching our resources and strengths as an institution to society's needs and goals in appropriate ways.

Therefore, we do not believe that it is the principal role of the humanities, arts, and social sciences in a liberal education to serve as the repository for "values" or as the vehicle through which values are transmitted or inculcated. For us, the humanities, arts, and social sciences have a primary educational role that is two-fold. First, they introduce the student to forms of culture, and to attitudes and sensibilities that are not only of interest and reward in their own right, but also help the student to think about, understand, and relate to other human beings and to society. Second, they provide the student with new conceptual dimensions for understanding and participating in the life of our time.

In the spring of 1974 the faculty approved a new form for the undergraduate humanities requirement, which is now called the Institute Requirement in the Humanities, Arts, and Social Sciences. This requirement continues to consist of eight half-year subjects, but now includes a distribution requirement in a range of areas, a small core of concentration in one aspect of humanities, the arts, or social sciences, and several electives. The new arrangement provides students with a broader range of choices in the freshman and sophomore years and has reduced the load on the few subjects that formerly were allowed to satisfy the Humanities Requirement.

There is continuing interest among the faculty with regard to the Requirement in the Humanities, Arts, and Social Sciences. Issues on which opinion varies include: the amount of diversity and choice there should be in the list of subjects approved for this requirement; the desirabilty of a return to a more limited set of offerings, or perhaps to unique offerings to satisfy some part of this requirement; the appropriateness of present criteria for distribution and concentration within the requirements; and approaches to teaching writing at the Institute. We note here that the issue of a writing program has been a significant matter for faculty discussion during the past year.

Writing subjects have been part of an M.I.T. education since the early days of the Institute, although instruction has taken different forms as student needs and interests have evolved over the years. During the past five years there has been a growing concern with the need to help M.I.T. students improve their writing skills, a concern which has parallels in many other colleges and universities. Since the abilities, experience, and needs of M.I.T. students vary widely, what seems to be needed is not a single required "Freshman English" subject but rather a variety of subjects from which students can choose. A popular subject called "Writing and Experience" was developed on an experimental basis in 1972, and by 1974 had evolved into a Pilot Writing Program having at its core several subjects in the Department of Humanities, but also including subjects in other departments, cooperative instruction in technical subjects in four Schools, workshops of many kinds, editorial conferences, thesis writing seminars, and informal seminars on writing open to the entire M.I.T. community. The philosophy of education which underlay many of these activities developed, over the years, into a fairly coherent set of values and goals which appeared to be at variance with the philosophy and goals of other parts of the Department of Humanities concerned with teaching literature and writing. The educational philosophy of the Pilot Writing Program was designed to be supportive of a student's attempts to write, and "non-judgmental" in discussing student work. Critics of the Pilot Writing Program argued for greater attention to formal structure and style in the written piece.

In the spring of 1975 the Dean of Humanities appointed a committee of M.I.T. faculty members and outside advisors to recommend a course of action. The Committee submitted its report in June 1976, and we noted its major recommendations in last year's Report and anticipated a year of discussion throughout the Institute. The Committee's Report contained an analysis of the writing needs of M.I.T. students and of the context of writing instruction at M.I.T. and at other univer-

sities, and it evaluated the extent to which the Pilot Writing Program appeared to be achieving its own goals and to be meeting the writing needs of M.I.T. The Report included a wide range of educational and administrative recommendations, the thrust of which was to endorse a variety of approaches for integrating writing into the M.I.T. undergraduate education, including but not limited to that associated with the Pilot Writing Program. For example, the Report recommended that new subjects in expository writing, science writing, and technical writing be established; that writing be emphasized in subjects given throughout the Institute; and that a Resource Center offering diagnostic and tutorial services be established. The Report also recommended administrative arrangements for the support of a permanent writing program.

Unfortunately, some members of the Pilot Writing Program and their students (and even some alumni) who had developed a strong sense of commitment to the style of teaching developed in the Pilot Writing Program, interpreted actions taken to implement the recommendations as an effort, not of support and growth, but of opposition to the Pilot Program's goals and even existence. In May, the faculty held a broad-ranging discussion of the educational and policy issues involved. At this time, the intent of the Committee's recommendations and the actions to implement them taken by the Dean of the School of Humanities and Social Science were clarified and supported.

The problem of writing at M.I.T. is now being addressed directly and on a broad front. All faculty share the desire that M.I.T. students write better so that they will be able to play a more valuable role in society and to express their own individuality with greater ease and satisfaction. The School of Humanities and Social Science is working hard to develop a permanent Writing Program which will achieve these objectives, although we expect that it will take several years to develop a fully articulated program that meets the diverse range of needs which have been identified.

III

Turning now to the School of Engineering we encounter an organization besieged by new-found popularity and a faculty hard at work adapting its educational programs to new technical challenges, heavy student loads, and the results of ongoing financial limitations.

During the "engineering science" era, the linkages between the School and the practice of engineering in many industries weakened, although strong relations continued with industrial research laboratories. During the past decade, as the School substantially increased its emphasis on the development of technology and its use in the engineering process, existing relations with the practicing professions and industry were greatly strengthened and new relations built. The motivation is obvious: The School of Engineering must not only relate to the foundations of engineering — that is to the engineering sciences — but it must also relate to the practice of engineering as a profession. This transition to a more balanced perspective was accomplished through the desire of both faculty members and students to study broader applied problems, coupled with a growing interest in synthesis and design.

In previous years, we have reported on a self-appraisal project in the School of Engineering that focused particularly on efforts to improve the quality of some educational offerings and at the same time eliminate some undesirable overlap. A Committee on Engineering Education (C.E.E.) was created in the fall of 1975 as an outgrowth of that School-wide self-appraisal project. It had become apparent that a broad-based, major review of the entire educational program in the School should be undertaken. The particular factors that made the review timely included external pressures such as the changing role of engineers in society, the changing character and direction of research support, and the changing social and political environment in which engineering is practiced.

In October 1976 the C.E.E. issued a comprehensive progress report which included a statement of Goals for Engineering Education at M.I.T. to serve as a foundation for the School's programs. These goals incorporate the commitments which the School's educational programs have to students, the society at large, the engineering professions, and to the Institute. The Committee considered appropriate academic programs and environments for undergraduate and graduate engineering education, developing a set of guidelines for the future planning of educational innovations which can serve as a basis for a broader discussion of undergraduate education.

The Committee concluded that there are subjects, at both the undergraduate and graduate level, which are of interest to more than one department in the School of Engineering but which it is difficult for individual departments to develop due to personnel and budget limitations. Examples of such subjects include:

- service subjects to students, such as computer programming;
- subjects of common interest but not central to a departmental program, such as entrepreneurship or innovation;
- subjects that integrate knowledge from several disciplines and are conducive to synthesizing this knowledge, such as design subjects;
- subjects at the interface between engineering and other professions, such as those which involve aspects of economics, law, and management.

The Committee on Engineering Education is arranging with the appropriate Institute faculty committees plans for conducting a three-year experiment in creating, offering, and evaluating School-wide subjects.

Most of the engineering sciences such as thermodynamics, structural mechanics, fluid dynamics, etc. are part of the core curriculum in most engineering departments. Al-

though there are gaps and overlaps in the subject offerings at each level, each department has a unique perspective on the discipline and quite naturally desires to retain its own special version. The School has begun to bring together faculty members from different engineering departments to form "area committees." These committees are ad hoc in nature and meet to consider such issues as the scheduling of similar subjects to provide students with optimum flexibility, improvement of the advisory system to students in the area, the adequacy of the existing range of subjects, and new curriculum development directions. Another proposed activity of these area committees will be to develop School-wide undergraduate laboratories. Over the years many undergraduate laboratory facilities have deteriorated. The cost of acquiring and maintaining up-to-date equipment is too high for most departments to support excellent undergraduate labs. The area committees can help faculty to plan, staff, operate, and maintain interdepartmental labs for the benefit of all departments.

We share with the School of Engineering the goal of continuous evolution of educational programs and streamlining where appropriate. We are aware of the resource limitations which make these processes difficult for the School and expect to give this problem particular attention in the coming years.

The Joint Harvard-M.I.T. Program in Health Sciences and Technology has sponsored collaborative research projects by physical scientists, physicians, and engineers at hospitals affiliated with Harvard University.

EVOLVING ACADEMIC FORMS

As we examine the activities of M.I.T. over the past five years, a striking feature is the increasing permeability of the boundaries between departments and between Schools. In both research activities and educational programs, groups of people form around mutual interests, creating a network of activities which may cut across traditional organizational lines. Through these working relations they invent new ways for the Institute to address particularly complex and challenging intellectual issues.

Such developments have been part of the M.I.T. tradition for many years. For example, the Research Laboratory of Electronics, established immediately after World War II, set a style in interdisciplinary and interdepartmental research that was influential on this campus and nationwide. We have reported annually on recent M.I.T. activities in such areas — in the field of energy (which we will discuss in detail later in this Report); in the Division for Study and Research in Education; in various activities of the Schools of Engineering and Management; in our varied efforts to address the issues of humanity, technology and society; and in the wide range of health-related activities which have grown up at M.I.T. during the past decade. Work in the last two areas has now progressed to the point that new organizational forms seem needed to foster their continued development. In the past year we have reached the decision to establish a College of Health Sciences, Technology and Management, and to work toward the establishment of a College of Science, Technology and Society. Our use of the term "College" for these two efforts comes from the sense of the word "collegium" — a group of colleagues — and is intended to describe a group of educational and research activities which transcend the concerns of any single department, School, center or laboratory, but which are present in many of them. That is, the designation "College" is being used for the first time in the history of M.I.T. to designate an academic entity that has its roots in several Schools and that involves not only research but also educational programs having a broad common focus (such as health) developed jointly by members of the faculty from several departments.

I

The College of Health Sciences, Technology and Management

Over the past decade research in the sciences of health and life has been increasing at M.I.T. until it now comprises nearly one-third of the Institute's research effort and is carried out in all five of M.I.T.'s Schools and in numerous interdepartmental laboratories and centers. We have reported several times on various aspects of this growth and this year will discuss several new developments involving the Harvard-M.I.T. Joint Program in Health Sciences and Technology; the establishment of an M.I.T. College of Health Sciences, Tech-

nology and Management; and a new physical facility which is to house important components of these activities along with the M.I.T. Medical Department.

During its seven-year history, the Harvard-M.I.T. Joint Program in Health Sciences and Technology has developed educational programs to train physicians having special skills in the physical, engineering, and other quantitative sciences; and graduate programs for engineers and scientists in medical engineering and medical physics. These are people who are needed if modern science and technology are to diffuse rapidly, responsibly, and economically into medicine and are to have a broad impact on human health. The Joint Program has also fostered the growth of major research projects in which multidisciplinary teams of physical scientists, physicians, and engineers are participating, and is encouraging the organization of medical engineering departments in hospitals affiliated with Harvard. As intended, these activities have significantly expanded the opportunities for collaborative research, helping to bring together the complementary resources, interests, and talents of faculty and students at both Harvard Medical School and M.I.T.

While this program was developing it became clear that other M.I.T. faculty members and students were developing strong interests in health-related fields which were not particularly appropriate for cooperation with Harvard academic units. During this period many purely M.I.T. activities developed for which the aegis of the Joint Program was not fully appropriate. As the scope of such activities grew it became obvious that it was desirable to find a way, somewhat independent of the Joint Program, to facilitate these and other efforts in both education and research. We have also felt that there would be great benefit from consolidating some of them in a common, centrally located physical facility.

During the past year it has become possible to solve several of these problems at once.

a. When the Joint Program in Health Sciences and Technology was established it had been agreed that some $10 million in new endowment would be needed to support M.I.T.'s and Harvard's permanent commitment to the endeavor. This year the funding goal has virtually been reached, the program has amply justified our hopes for it, and therefore the Executive Committee of the M.I.T. Corporation and the Harvard Board of Overseers approved its permanent establishment as a jointly governed **Division** of Health Sciences and Technology. This inter-institutional status transcends that of research units such as the Harvard-M.I.T. Joint Center for Urban Studies, in that the Division will be able to sponsor degree programs and selective faculty appointments, in addition to conducting joint research projects.

b. The development of the Joint Program in Health Sciences and Technology has been greatly assisted by the Health Sciences Fund, an independent, non-profit organization established in 1974 by Uncas A. Whitaker to provide support for research projects in the life sciences and biomedical engineering. The Fund has initially supported students at M.I.T. and at the Harvard Medical School who are engaged in thesis research, and faculty members at both institutions, primarily junior but not exclusively so, who are initiating research projects. Though the Fund has not limited its support to students and faculty associated with the Joint Program, a significant part of its $500,000 annual funding has supported Program-related work.

c. We have been most fortunate in the past few months to have achieved the support of the Whitaker Foundation and the Pew Memorial Trust for the construction of new physical facilities to house many of M.I.T.'s health-related research and educational activities, and the M.I.T. Medical Department. This opportunity has made it possible to establish a College of Health Sciences, Technology and Management. The health-related activities to be brought together in the College transcend the concerns of any single department, laboratory, center or School, but are present in many of them. Among the educational and research programs that will be developed under the college umbrella will be the areas of human biology, physiology, and experimental medicine; the area of Health Services Planning and Management; the M.I.T. components of the Harvard-M.I.T. Division of Health Sciences and Technology, including the new doctoral programs in medical engineering and medical physics. The College will serve as an integrating focus for much but not all of M.I.T.'s health-related work that does not involve Harvard units. It is anticipated that practically all of the College's faculty will hold joint appointments in one of the five Schools, that subjects and academic programs will be developed jointly with the relevant departments and Schools, and that students will be enrolled in the various departments of M.I.T.

d. One of the most exciting features of the physical plans for housing much of M.I.T.'s health-related work is the possibility of having in the same complex both the new College of Health Sciences, Technology and Management and the M.I.T. Medical Department which began as a typical college health service but over several decades has become a large multispeciality group practice. This year, the staff of 24 full-time and 38 part-time physicians and 202 other professional support personnel cared for some 25,000 patients who made more than 115,000 visits to the Department. The Department assumes responsibility for the complete health care of our 8,500 students under the student health plan and for some 1,500 of our students' dependents who opt to receive their care in the Department. Since 1933, as an employee benefit, the Department has also offered free ambulatory primary care to our employees, and some 5,000 M.I.T. and Draper Laboratory employees currently take advantage of this privilege.

In 1973 the Medical Department established the M.I.T. Health Plan, a comprehensive, pre-paid medical care program. The M.I.T. Health Plan, organized in cooperation with Blue Cross and Blue Shield of Massachusetts, is one of three programs in the nation organized by university health services to offer a full range of pre-paid health care services to employees, and is the only program offered by a university without a medical school. (Yale and Harvard offer similar programs.) Membership in the Plan was initially limited to 1,000 employees and their dependents but high levels of patient and physician satisfaction and favorable cost experience during this pilot phase resulted in our decision to open

enrollment in July 1975. The membership has grown at approximately the predicted rate of 1,000 members per year, and the current projection of steady state is some 12,500 members, or some 38 percent of those eligible.

By serving the entire M.I.T. community, the Medical Department has been able to develop programs and services which could not be supported within the economic framework and scale of a health service limited only to students. More importantly, this diversity has enabled the Department to attract a highly skilled and concerned professional staff, thus assuring high quality medical care for students as well as other patients.

While the Medical Department's primary purpose is delivery of medical care, there exists a great interest and enthusiasm among the staff for collaborative efforts in teaching and research with academic departments and laboratories at the Institute. The medical staff has sought innovative approaches to the delivery of high-quality health care services in such areas as extensive use of people other than physicians to provide some kinds of health care, psychiatry, uses of intermediate care inpatient programs, and development of prepaid methods of organizing and financing the delivery of medical care. The staff has provided joint thesis supervision for students engaged in thesis work and other academic projects, and has provided a patient data base for research projects conducted by faculty members and students.

The expansion both in the spectrum of services delivered and the population served has had the inevitable — and foreseen — effect on the Medical Department's space requirements. Present facilities are inadequate by virtue of size, plan, and construction to accommodate even current services. The construction of a new health-related facility will not only provide badly needed and modern space for the Medical Department, but will do so as an integral part of a project which will house the new College of Health Sciences, Technology and Management. The Institute will, of course, proceed through normal channels to request and obtain the Certificate of Need for health service facilities required by Federal and state law prior to initiating construction.

We confidently predict that new and mutually productive relationships among M.I.T. faculty and staff in health fields will benefit both those whose primary mission is service and those whose primary missions are teaching and research. The College of Health Sciences, Technology and Management represents a major commitment by M.I.T. to apply its resources and proven strengths toward improving the health of our nation and the quality of its health care. The next few years should thus be exciting ones for all of us.

II

Toward a College of Science, Technology and Society

We described last year, in noting the 25th anniversary of the establishment of the School of Humanities and Social Science, the long-standing concern M.I.T. has had that technological and societal problems are so inextricably interwoven that their relationship should be an explicit subject for research and education at M.I.T. In the past few years there have been a wide range of activities throughout the Institute addressed to this issue, among them a study group initiated by the School of Humanities and Social Science to develop a way by which a measure of convergence of the humanistic and technological streams of the Institute could be attained. From the work of this group, after discussion with a substantial number of faculty members, there emerged a proposal to develop a new entity within M.I.T. tentatively to be called the College of Science, Technology and Society, having a faculty and a fellowship of scholars drawn from many disciplines and departments, an undergraduate teaching program, a research center, and an organization to support continuing study groups addressing themselves to selected contemporary problems. The proposal for the College, in the form of a prospectus which grew out of several years of thought and discussion, has been circulated to the M.I.T. Faculty Council for discussion and has been submitted to potential donors.

The intellectual purposes of the College are clear: the findings of science and the applications of engineering are now so directly engaged in the workings of society that professional education for scientists and engineers must include the study of ways in which scientific, technological, social and human elements interact to give shape to society; and the study of such interactions should be done explicitly through the investigation of problems in modern society which are produced by the interaction. The primary concerns of the College — concerns about the nature, power, and limits of scientific thought; about the interaction between science and social institutions; about the relationship between technological innovations and the quality of the human and natural environments; and about living in modern society — are a fundamental and integrated part of the lives of scientists and engineers at M.I.T. There is, within M.I.T., a great deal of information, the product of both research and experience, about the way in which the interactions of scientific, technological, and social factors determine the shape of modern life. This information and experience is of different kinds and is now, ordinarily, contained in different departments, Schools, and centers. We believe that much of this diverse evidence could acquire deeper meaning and contribute to further understanding of certain aspects of modern society if it could be brought into new combinations and fitted together in more extensive relationships. There is no conflict between the new effort and the many policy-oriented programs at M.I.T. and elsewhere, for the focus of the College would be on the humanistic aspects of technological society — its culture, the lives of its people, their attitudes, perceptions, problems, goals, and prospects. It would seek to be an integrative cultural force on the campus.

The purpose of the College will be to supply a means that does not now exist to develop the requisite activities. The need therefore is to develop an institutional form which will provide a base sufficiently secure to maintain the integrity of the effort while supplying the direct connections with Schools and departments necessary to ensure the performance of the desired integrative function.

The most difficult question with regard to the administrative structure of the new entity is its prospective relationship to the various Schools in which related work is currently under way. It was initially proposed that the College be independent of the five Schools, but after much discussion and in view of concerns that emerged among some members of the faculty, we have concluded that the program should be started and operated in association with the School of Humanities and Social Science, from which it grew. This will not only establish a clear relationship between the College and the School, but will also allow the program to start more quickly and efficiently. We expect that support adequate to the program's initial needs will be obtained in the fall of 1977, and that further support will be obtainable as the program grows. We expect that the coming year will see this new enterprise getting effectively started.

FIELDS IN FLUX

As we noted at the beginning of this Report, M.I.T. is a culture for research and educational activities which are constantly evolving. This, combined with changes in secondary schooling, requires a periodic reassessment of the efficacy of our undergraduate programs, as we discussed earlier. Occasionally, it also leads to the development of new organizational forms such as the colleges in order to most effectively match the potential of growing faculty and student interests with the needs of society.

But most of M.I.T.'s work is done within the familiar structure of departments, Schools, laboratories and centers where there is a comparable ebb and flow of stimulating new ideas, programs, and educational activities. The Institute's intellectual health and vitality depend on the development of these new activities which capture the imagination of students and faculty and which provide stimulation and new perspectives for ongoing programs. Support of such activities represents investment in the Institute's intellectual capital and, as they develop, new sources of recurring financial support often open up. M.I.T.'s ability to create programs in which government, industrial, and university interests can come together around shared concerns creates a remarkably productive context for success. But in the beginning many of these efforts are critically dependent on the foresight of private supporters.

I

An excellent example of this phenomenon is the Energy Laboratory which we have reported on each year since its establishment in 1972. Laboratory projects now involve 60 Energy Laboratory staff members, 70 faculty members, and 150 students from various departments in all five M.I.T. Schools, especially from the School of Engineering and the Sloan School of Management. The Laboratory has become a major source of support for faculty and students in these Schools. The annual funding for the Laboratory has grown to over $7 million, of which $450,000 are discretionary funds contributed largely by corporate partners to support the development of projects in new research areas. While the Energy Laboratory, at its founding five years ago, was well ahead of the Federal government's capacity to fund either basic or applied research in the energy area, private organizations, particularly in industry, recognized the need and supported its initial efforts. Gradually an appropriate balance between public and private support is being attained.

In order to increase the nation's capability to establish effective energy policies, this year the Energy Laboratory, building on its well-established energy policy group, developed an M.I.T. Center for Energy Policy Research as a context for collective effort by industry, labor, public interest groups, government, and other universities, to focus on long-term energy policy. The main objectives of the Center are: 1) to build up the resource base of technically competent, comprehensive studies of important issues in the energy area; 2) to use this analysis to support the preparation of papers on individual policy issues directed towards operating executives, government officials, and the informed public; and 3) to support these policy studies with an improved foundation of data and research results on fundamental areas of energy economics, technology, and management. Invitations to join the Center's advisory board have been extended to an initial group of organizations with the insistence that a commitment to intense professional interaction and collaboration is a vital aspect of participation. Emphasis is being given to diversity of participants and sponsors to help ensure the objectivity and credibility of the work. The response to the establishment of this Center has been overwhelmingly positive, and its financial support is growing steadily. (It is of interest to note that the Energy Research and Development Administration [ERDA] has not yet been able to support policy research so private support for the Energy Policy Center is essential.)

The foresight of the Laboratory's early supporters is being confirmed. Because of their early commitment the Institute has been able to build a Laboratory unique in its range of activities and especially in the depth of its analytic capability which served as a national resource before most people were aware of an "energy crisis," and is now a substantial contributor to its understanding.

II

Equally exciting and promising was the establishment last year of a Plasma Fusion Center to serve as an intellectual and administrative focus for work in plasma physics and fusion. This move was made desirable by the growing level of activity in the plasma field as a result of the highly successful operations of the initial experiments on the M.I.T. fusion machine, Alcator, which has subsequently produced the highest level of performance so far achieved in such a device.

In addition to the work on confinement conducted on Alcator at the Francis Bitter National Magnet Laboratory, at M.I.T. there are strong complementary programs presently under way in plasma confinement theory, experimental plasma research, conceptual studies on future fusion power plants, and research in basic technologies of critical importance to fusion power. Major objectives of the new Center will be to develop a successor machine to Alcator, capable of even better performance, and to better relate work on the Alcator machines with other theoretical and experimental work at the Institute.

While a majority of work in plasma and fusion has been supported by a combination of National Science Foundation, ERDA, and M.I.T. funds, there came a point last year when timely industrial support was responsible for the continued progress of the M.I.T. effort. A much more powerful generator was needed to drive the new Alcator C, but no appropriate equipment budget could support the cost. After some inquiry it was discovered that Consolidated Edison in New York was retiring a suitable 200 megawatt generator and was willing to make it available to M.I.T. So, in the very near future a generator which has given years of reliable service to a public utility will be serving as the basic component of the power supply for advanced thermonuclear research at M.I.T.

Dr. Samuel C. C. Ting, Thomas Dudley Cabot Professor of Physics, acknowledges the congratulations of his colleagues after being named co-recipient of the 1976 Nobel Prize in Physics. Dr. Ting was cited "for pioneering work in the discovery of a heavy elementary particle of a new kind."

III

During the past decade the School of Engineering as a whole has found considerable intellectual stimulation from its increasing collaboration with industry. During a decade in which the School substantially increased its emphasis on the development of technology and its use in the engineering process, previously strong links between engineering and the sciences were balanced by joint interest on the part of both M.I.T. and a number of industries in more applied problems. The Energy Laboratory involves a large number of faculty members and students from the School of Engineering in such activities. The Polymer Processing Program, which we have mentioned in previous years, now has an industrially sponsored research volume exceeding $300,000 per year and recently a similar program in ceramics was started by the Department of Materials Science and Engineering.

Contemporary challenges across a wide range of industries in the areas of manufacturing and productivity are also of interest to the School of Engineering. Major advances, particularly those involving the sophisticated use of computers, will require the combined commitment of industry, labor, universities, and government, and to this end the School has established a Laboratory for Manufacturing and Productivity hoping to draw faculty and students from many departments and Schools of the Institute committed to working with industry, labor, and government on the development of new manufacturing technologies and systems.

To further strengthen the association between the Institute and the engineering professions in industry and to provide for our students educational opportunities which do not exist on campus, the School this year established an Engineering Internship Program, incorporating the important elements of cooperative education into a combined S.B.-S.M. program. This program, which involves all departments of the School, provides not only new opportunities for students, but also opportunities for faculty to work more closely with engineers in industry and for industry to keep abreast of research progress at M.I.T.

As we mentioned earlier in this Report, undergraduate and graduate enrollments in engineering at M.I.T. have been increasing rapidly during the past three years, reversing the decline experienced in the late 1960s and early 1970s. Further increases in undergraduate engineering enrollments appear highly likely over the next two years. These rapid growths, combined with growth in the volume of research conducted in the School, have created substantial overloads on a faculty whose size has remained constant. It is essential that we provide new resources to support these higher levels of activity and we propose to establish a special development fund for the School of Engineering within the current Leadership Campaign. This fund would primarily support the expansion of the faculty through the addition of a number of assistant professors, but would also support curriculum development activities and provide resources for the School to develop new uses of computers and television in teaching, provide seed funds for new, cooperative research projects, and enable the School to invest in equipment needed for new areas of education and research.

IV

A quite different area which is just on the brink of a major breakthrough in the opinion of many, is our understanding of how the human mind works. For over 25 years there has been intensive interest and activity at M.I.T. in a range of topics that traditionally would have been designated "study of the brain and mind." Work on these topics has included investigations in cybernetics, the communications sciences, the computer sciences, and theory of information processing, whose intellectual roots go back to the pre-World War II work of Norbert Wiener. Neurophysiology, learning, vision, psycholinguistics, and the study of cognition have been major areas of interest for the Department of Psychology since its establishment in 1964. Linguistics and philosophy, too, have drawn closer to these issues in recent years. Inquiry into this range of questions has brought together electrical engineers, computer scientists, neurophysiologists, biologists, psycholinguists, linguists, philosophers, and mathematicians. People from these diverse disciplines are focusing on a common goal — to understand the structure, organization, and function of mental processes, their role in the causation of human behavior, their physical basis, and their growth in the individual and the species. These fields are currently in a state of rapid development largely because of new modes of conceptualizing the issues. The simultaneous achievement of conceptual, theoretical, and experimental advances has endowed old interests with new vigor. The result has been a major liberation of scientific imagination, occurring at M.I.T. and elsewhere.

Faculty members from M.I.T.'s Departments of Linguistics and Philosophy, Psychology, and Electrical Engineering and Computer Science, with support from the Alfred P. Sloan Foundation, will lead a visiting scientist program and a series of major workshops in the cognitive area during the next two years with the goal of developing a more precise sense of the most promising lines of inquiry. We are encouraged that it has been possible to find support at a critical stage in the development of what could be a major new intellectual field, and are confident that as it develops momentum and reaches the stage where new organizational and funding mechanisms would be appropriate, they will become available.

V

As we noted earlier in this Report, research and training in fields related to health have been steadily growing over the past decade. This growth has been particularly significant in the fields of basic and applied biology, where an intellectual revolution took off from the discovery in 1953 of the structure of DNA, which signaled the beginning of an era in molecular biology. M.I.T. faculty members in this area have been most distinguished contributors.

The life sciences reflect the areas of basic scientific inquiry where practical applications are most often readily apparent to the general public. This is in part a source of their great strength; the desire to improve the nation's health care doubtlessly explains why Federal research support has continued at a high level during a period when many other fields of science experienced declines. Yet the very success of the life sciences has given rise to special problems. One acute concern is that of the scientists' ethical responsibility to the wider public — most vividly illustrated by the case of recombinant DNA research, which involves the splicing of different genes.

This year M.I.T. was involved in a great deal of discussion of the responsibility of the scientist and the development of new arrangements to provide safe conditions for this research at M.I.T. The National Institutes of Health (NIH) Guidelines for Recombinant DNA Research were published in June 1976, just at the time that the Mayor and City Council of Cambridge had become aware of Harvard's plans to build a so-called P-3 laboratory to carry out recombinant DNA experiments. M.I.T. had a laboratory of this type in the Center for Cancer Research which, after some small modifications, was certified by an M.I.T. committee as satisfying the NIH requirements. In July 1976, the Cambridge City Council passed a three-month "good faith" moratorium on P-3 recombinant DNA experiments in the City of Cambridge. This moratorium was later extended for another three months so that a citizen group appointed by the City Manager could study the situation and make recommendations to the City Council.

The six-month delay in using M.I.T.'s laboratory caused considerable frustration, but during that period members of both the M.I.T. faculty and administration cooperated intensively with the City Council and the citizen review board. In January, this board recommended unanimously that P-3 recombinant DNA experiments could go on in Cambridge if certain precautions in addition to those in the NIH Guidelines were taken. Experiments of this type were carried out at M.I.T. during the spring term.

Local challenges to recombinant DNA research have since been springing up in many university communities. In addition, the issue has moved to the national level where numerous members of Congress have proposed legislation for supervising such research. The effort on the part of scientists to prevent precedent-making restrictions and regulations continues at this time. It might be a short step from control of DNA research to limitations in other fields. Undoubtedly, in the years to come, we will hear more frequent arguments to restrict research in some fields of science.

In recognition of the seriousness of this issue the group involved in planning the College of Science, Technology and Society has been holding a seminar entitled "Limits to Inquiry" which may develop into a continuing study group. We look forward to continuing these discussions, for a civilization which limits its inquiry out of fear of what it might learn will soon stifle both its intellectual life and its social development. The issues are major ones but the goal is to find ways to discuss them throughout the society and to manage the consequences of new knowledge, not to cut off its source.

SUMMING UP

M.I.T. is an extraordinary place with a proud heritage of service and a vibrancy unmatched anywhere — firmly rooted in its dedication to science and technology for the benefit of humanity. Its achievements are fundamentally the achievements of individuals working together toward shared goals. In this Report we have tried to share our view of M.I.T.'s problems and opportunities in the mid-1970s. A primary goal of this administration has been not only to encourage and support the efforts of faculty members and students in developing new intellectual fields and modes of education appropriate to M.I.T.'s leadership role in our society, but to do so in such a way that the financial base on which the Institute rests is strengthened. Only in this way can M.I.T.'s programs be resilient to shifts in national mood and erratic economic conditions; and, equally important, only in this way can we underwrite the Institute's independence and the creative initiatives which keep it strong. Our efforts in this regard have been of two kinds — to maintain fiscal control in an economic era which is highly problematic for institutions of higher education, and to increase the private sources of support on which M.I.T.'s independence depends through the Leadership Campaign. We are pleased to report significant progress on both fronts.

In our Report of a year ago we spoke of progress toward elimination of the Institute's operating deficit and of our two fiscal goals for the next few years. The first goal was to bring operating expenses and normal operating revenues closer towards balance so that there would be no call on capital in the form of funds functioning as endowment, and so that we would be less dependent on current unrestricted gifts for the support of operations. This objective is important because we must, except in brief periods of adjustment to major financial discontinuities such as those of 1973-74, set aside each year for capital purposes some portion of that year's receipts of unrestricted gifts.

The past year evidenced encouraging progress toward this goal. The year closed with revenues, including unrestricted gifts, in nominal balance with expenses (the precise deficit was $126,000, an amount less than 0.05 percent of the expense budget). This essential elimination of the operating deficit was achieved a year earlier than we anticipated as a result of increases in current gifts — an outcome attributable to the Leadership Campaign, improvements in reimbursement from research sponsors for the indirect costs of research, increases in revenues associated with the growth of the Industrial Liaison Program, and close attention to cost control by those responsible for expenditures at the Institute.

We anticipate that the operating budget will balance again during the current year, and expect as well, to make some progress during the next three years toward the goal of making some portion of current unrestricted gifts available for capital purposes, including additions to funds functioning as endowment.

Our second goal, as stated a year ago, is to achieve a balance between the **rates of growth** of expenses and of revenues so that the financial state of the Institute is more stable. While progress has been made toward this objective, the problem is highly refractory, and dynamic balance remains an unachieved objective, progress toward which is critically dependent upon the level of inflation in the economy, continued growth in gift support of Institute operations, and further improvements in the annual rate of growth of investment income.

One aspect of the financial management of the Institute during the past year deserves special mention. In an effort to provide better continuity and to encourage a somewhat longer planning horizon, last year we prepared budgets for a two-year period. While the plans for 1978-79 were, of necessity, more tentative and less detailed than those for the current year, the longer look at programs, needs, and opportunities was, we believe, welcomed by all who participated in the process. As we move into budget making this year, reviewing and making precise the budget plans for 1978-79 enunciated nearly a year ago, we plan to add another year to the planning cycle.

A particularly important and rewarding part of the two-year planning process was a series of meetings with individual department heads and associated deans for the purpose of reviewing departmental programs, intellectual issues and concerns, and resource needs for the near term. These meetings left us with both a clarified picture of the fundamental intellectual and academic framework of the Institute, and a sense of the extraordinary quality and vitality of the 23 academic departments.

In May, slightly more than two years into the five-year M.I.T. Leadership Campaign, we had passed the halfway mark to the target of $225 million with pledges and receipts in excess of $130 million. As we mentioned earlier, we are gratified by this success but by no means complacent because we expect the second half of the Campaign to be more difficult than the first. Not only are we once again facing a lackluster economy and tax legislation discouraging to philanthropy, but to a considerable extent our first-half accomplishment was made possible by strong support from those individuals and corporations closest to M.I.T. This is not to say that we are discouraged, rather that we are preparing to work harder during the second half of the Leadership Campaign and we anticipate that the M.I.T. Corporation will join us in this surge.

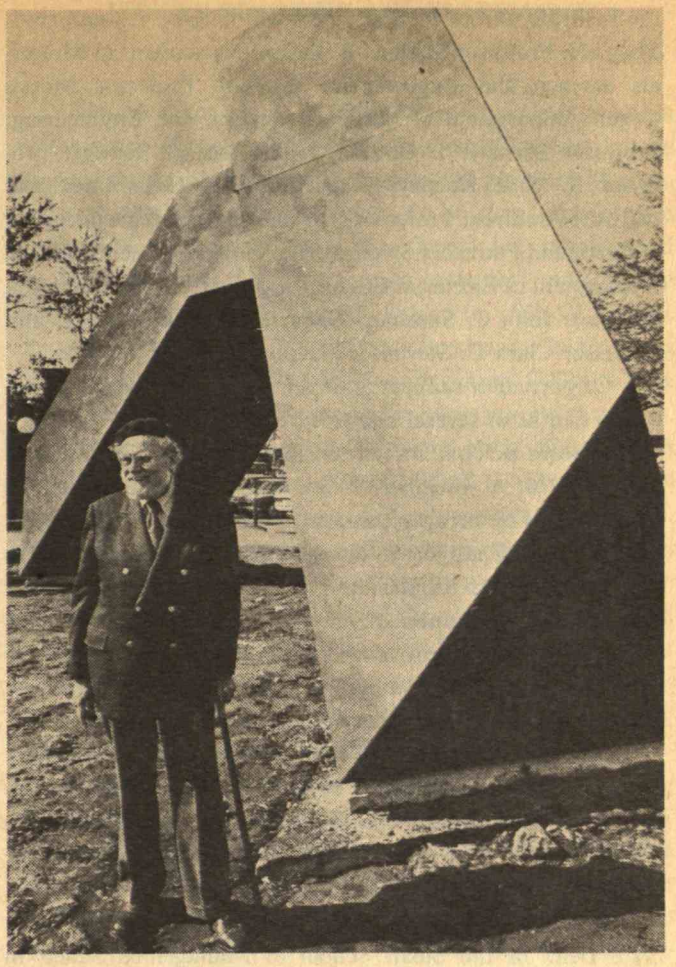
Three members of the Corporation have joined Howard W. Johnson in the direction of the Campaign. Edward O. Vetter and W.B. Murphy have become Co-Chairmen (with Paul F. Hellmuth) of the Campaign to assist in the direction of the drive and in solicitation. Richard L. Terrell is heading our new National Business Committee of alumni and friends to assist in developing support for M.I.T. in the industrial community.

The Industrial Liaison Program and the Associates Program continued to grow during the year, and the additional income these programs provided played a very significant role in the improvement of the financial situation of the Institute. Many other results of the Campaign have had a very positive

effect on our operations. In particular these include the 17 endowed professorships and faculty development chairs, and the anonymous gifts of the $800,000 in matching funds which helped raise the Alumni Fund to a record high of $4.8 million. We especially note two magnificent capital gifts: The generosity of the Whitaker Foundation and the New York Community Trust which pledged gifts of $10 million, and the Pew Memorial Trust which provided $9 million, have made possible the proposed health sciences and health services facilities described earlier. Plans for construction are proceeding.

During the next year three major projects will be given special emphasis — a $10 million development fund for the School of Engineering; the $5 million needed to complete the funding for the Athletic and Special Events Center; and $6.5 million for the Visual Arts Facility which is the first part of a three-phase program to provide satisfactory work and study space for faculty and students engaged in the creative arts. The plan for the facility calls for three units to house the three major program components — visual arts including film and video, music, and drama. A challenge gift of $1.5 million has been pledged to begin the campaign for this facility.

We close our Report this year with a feeling of continuing pride in the privilege of being associated with M.I.T. The activities and achievements described in this Report are the result of very hard work on the part of thousands of people, each of whom has contributed time, energy, and above all concern on behalf of M.I.T. The years ahead will be full ones as we continue to address the major issues which are inevitable for an organization intent on being first-rate, creative, and relevant to contemporary society. We look forward to the challenge.



Sculptor Tony Smith attended an informal dedication of his monumental steel sculpture "For Marjorie," which was installed in the Westgate area in mid-May.

IN SPECIAL RECOGNITION

The individual efforts and distinctions on the part of the faculty at M.I.T. have been many during the past year. Four members of the faculty were elected to membership in the National Academy of Sciences; six were elected to the National Academy of Engineering; and four were elected to membership in the American Academy of Arts and Sciences. Samuel C.C. Ting, the first Thomas Dudley Cabot Professor, was honored as co-recipient of the Nobel Prize in Physics. Professor Ting was cited "for pioneering work in the discovery of a heavy elementary particle of a new kind."

Of special note during the year was the selection by the faculty of Dr. Robert M. Solow, Institute Professor and Professor of Economics, as the fifth recipient of the James R. Killian, Jr., Faculty Achievement Award.

The past year saw several changes in senior posts that deserve special mention. Professor Alan A. Altshuler was appointed Head of the Department of Political Science; Professor Gene M. Brown, Head of the Department of Biology; Professor Mildred Dresselhaus, Director of the Center for Materials Science and Engineering; Professor Richard Held, Head of the Department of Psychology; Professor Albert G. Hill, Director of the Plasma Fusion Center; Professor Arthur K. Kerman, Director of the Center for Theoretical Physics; Professor Samuel J. Keyser, Head of the Department of Linguistics and Philosophy; Professor Edward N. Lorenz, Head of the Department of Meteorology; Walter E. Morrow, Head of the Lincoln Laboratory, succeeding Dr. Gerald P. Dinneen who has been appointed Assistant Secretary of Defense; Dr. Melvin Rodman, Director of the Medical Department; and Dr. James Wei, Head of the Department of Chemical Engineering. Dr. Robert I. Hulsizer, Jr., Professor of Physics, began his term as Chairman of the Faculty.

We wish especially to note the decision of Professor Alfred A. H. Keil to resign as Dean of the School of Engineering effective August 31, 1977. Dean Keil will spend his time working with the Center for Policy Alternatives, the Energy Laboratory, and the prospective College of Science, Technology and Society. Dean Keil has given distinguished leadership to the School during a period in which the nature of engineering practice, and thus engineering education, have changed significantly. Dr. James D. Bruce, Associate Dean of Engineering, will assume full responsibility in the Office of the Dean until a successor to Dean Keil has been designated.

The past year also marked the retirement of eight distinguished members of the faculty. Their years of service to

the Institute and to their students will long be remembered. They are: Professor Michael B. Bever, Department of Materials Science and Engineering; Institute Professor Morris Cohen, Department of Materials Science and Engineering; Professor Bernard S. Gould, Department of Biology; Professor S. Neal Hartley, Department of Humanities and Institute Archivist; Professor Patrick M. Hurley, Department of Earth and Planetary Sciences; Professor J. Francis Reintjes, Department of Electrical Engineering and Computer Science; Professor John C. Sheehan, Department of Chemistry; and Professor Clark C. Stevenson, Department of Chemistry.

Of particular sadness to us during the year were the untimely deaths of several respected colleagues.

Carolyn B. Cox, Director of the Registry of Guests, died in July 1976. A. member of the M.I.T. community for 30 years, Mrs. Cox became Director of the Registry of Guests in 1960, providing support to foreign visitors to the Institute. In addition, she was responsible for arranging M.I.T.'s representation at ceremonies of other universities and for many years served as executive secretary to the Committee on Commencement. Her services to the Institute were characterized by their extraordinary grace and sensitivity.

Leicester F. Hamilton, Professor of Analytical Chemistry Emeritus, died in December 1976. A member of the faculty for 43 years, Professor Hamilton showed great devotion to generations of M.I.T. students and was extraordinarily active in guiding their development as young adults.

Thomas M. Hill, Professor of Management and Associate Dean of the Sloan School of Management, died in March 1977 after a long illness. A member of the M.I.T. faculty for 31 years, Professor Hill had done extensive work in managerial and financial accounting theory. During his long career at the Sloan School he had a substantial influence on the development of many of its major programs.

James Holt, Professor of Mechanical Engineering, Emeritus, died in August 1977. A member of the M.I.T. community for 40 years, Professor Holt was a specialist in heat engineering and repeatedly filled administrative posts in the Department of Mechanical Engineering in times of need.

Frank M. Lewis, Professor of Marine Engineering Emeritus, died in October 1976. Although he retired from the faculty in 1960 after a career of 43 years, Professor Lewis remained at the Institute as a productive and creative researcher until a year before his death. He was widely known for his contributions to the knowledge of torsional vibration, ship vibration, and propeller performance.

Jeffrey L. Pressman, Associate Professor of Political Science, died suddenly in March 1977 at the age of 33. Professor Pressman was widely regarded as the leading young scholar of American politics in this country. He engaged the intellect of his students and his concern for them was extraordinary. He is sorely missed by the hundreds of friends he made during his few short years at M.I.T.

John C. Slater, Institute Professor Emeritus, died in July 1976. Professor Slater was one of the world's leading atomic and solid-state physicists; he was at the forefront of his field even as a young scientist. He came to M.I.T. as Head of the Department of Physics in 1930, the same year that the late Dr. Karl T. Compton became President, and played a prominent role in the transformation of M.I.T. into a major force in science. His early work in solid-state physics led to the development of the transistor. During World War II his work at the M.I.T. Radiation Laboratory led to a general theory of the operation of the magnetron oscillator and the transmission of microwaves. Following the war, Professor Slater was a prime mover in the establishment of M.I.T.'s Research Laboratory of Electronics and Laboratory for Nuclear Science, and nearly 20 years later his interests in the electrical, magnetic, and other properties of materials guided the plans for establishing M.I.T.'s interdepartmental Center for Materials Science and Engineering. Professor Slater was named M.I.T.'s first Institute Professor in 1951, setting the standard for this faculty position which recognizes individuals whose contributions have had broad effect throughout M.I.T.

Hans-Lukas Teuber, Head of the Department of Psychology, died suddenly in January 1977, at the age of 60. Professor Teuber had been Professor of Psychology at M.I.T. since 1961 and Head of the Department, which he founded, since 1964. A gifted scholar and teacher, Dr. Teuber set new standards of conceptual breadth and logical rigor in the study of the relationship between brain and behavior — in perception, cognition, language, and memory. He was an inspiring and charismatic teacher, whose introductory psychology course was for many years the most popular undergraduate elective at M.I.T. A man who melded the instinct of a penetrating experimenter, the consummate style of a gifted teacher, and the sympathetic experience of a true humanist, his death was a most tragic and personal loss for many at M.I.T.

These men and women have been outstanding examples of the strength and variety of M.I.T.; they will be remembered and honored by generations of their students, friends, and associates.

Jerome B. Wiesner, President
Paul E. Gray, Chancellor

October 7, 1977

STATISTICS FOR THE YEAR

The following paragraphs report briefly on the various aspects of the Institute's activities and operations during 1976-77.

REGISTRATION

In 1976-77 student enrollment was 8,597, an increase of 115 over the 8,482 enrolled in 1975-76. This total was comprised of 4,468 undergraduates and 4,129 graduate students. Graduate students who entered M.I.T. last year held degrees

from 368 colleges and universities, 220 American and 148 foreign. The foreign student population was 1,491, representing 17 percent of the total population. The foreign students were citizens of 94 countries.

Degrees awarded by the Institute in 1976-77 included 1,018 bachelor's degrees, 971 master's degrees, 91 engineer's degrees, 379 doctoral degrees — a total of 2,459.

The number of women at M.I.T., both graduate and undergraduate, has increased continually. In 1976-77, there were 1,361 women students at the Institute, compared with 1,255 in 1975-76. In September 1976, 173 first-year women entered M.I.T., representing 16 percent of the entering class. In 1976-77, a total of 329 degrees were awarded to women.

STUDENT FINANCIAL AID

During 1976-77 the student financial aid program was again characterized by increases in total awards, in loans made, and in the amount of scholarship assistance. There was a significant increase in the number of individuals assisted.

A total of 2,131 undergraduates who demonstrated the need for assistance (47 percent of the enrollment) received $5,105,653 in scholarship aid and $2,966,836 in loans. The total, $8,072,489 represented a 14 percent increase in direct aid over last year.

Scholarship assistance was provided by the scholarship endowment in the amount of $2,137,709, by outside gifts for scholarships in the amount of $751,801, and by direct grants to needy students totaling $1,133,698 (an increase of 32 percent). Scholarship assistance from M.I.T.'s own operating funds was provided to the extent of $949,773 (a 131 percent increase). The special program of scholarship aid to minority group students represented an additional $132,672 from specially designated funds. An additional 395 students received direct grants from outside agencies, irrespective of need, in the amount of $1,147,541. Outside scholarship support thus totaled $3,033,040, another substantial increase over last year's total. A significant portion of the increase was again due to increased funding of the Federal government's grant-aid program. The undergraduate scholarship endowment was aided by the addition of new funds which represented an increase of $1,509,557 and which raised the principal of the endowment to $24,965,664.

Loans totaling $2,966,836 were made to needy undergraduates. Of this amount, $1,028,908 came from the Technology Loan Fund, $1,928,928 from the National Defense Loan Fund, and the remainder from other M.I.T. loan funds. An additional $765,800 (a 53 percent increase) was obtained by undergraduates from state-administered Guaranteed Loan Programs and other outside sources.

Graduate students obtained $1,419,385 from the Technology Loan Fund. Of this total, $659,295 was loaned under the Guaranteed Loan Program and qualified for Federal interest subsidies and guarantees. The total loaned by M.I.T. to both graduate and undergraduate students was $4,402,214, an increase of $486,443 over last year's total.

CAREER PLANNING AND PLACEMENT

The relevance of M.I.T.'s style of teaching and research to the needs of the world is nowhere more apparent than in the eagerness with which private firms and government agencies seek the Institute's graduates. To be sure, graduates in some fields in recent years have found the employment market depressed, and this was so again last year, but in general the demand for M.I.T. talent in 1976-77 showed characteristic strength. More private firms used the interview facilities of the Career Planning and Placement Office than in any year since 1968-69, the last of the boom years of the 1960s. Recruiting by government agencies was down slightly from recent years, but recruiting activity overall matched the level of 1969-70. In some fields, notably in chemical, electrical, and mechanical engineering, and at the master's degree level in management, there were more recruiters on campus than available students. Students seized the opportunity presented to them and the Career Planning and Placement Office, not to mention other interview locations around the Institute, was the scene of more than 5,600 interviews. This figure, too, approaches the traffic of the 1960s.

Improved economic conditions were reflected in a continuing decline in the number of alumni registering with the Office. The number dropped to 454 from 522 in 1975-76 and 627 the year before. Characteristically, there was an increase in the number of job descriptions received from employers seeking experienced personnel. As usual, the strongest demand from employers was for recent graduates in fields enjoying current growth. A large part of the Office's work is in helping alumni with a number of years behind them who wonder whether their careers have taken them in the right direction, and who would like to explore the alternatives that may be open to them.

FINANCES

As reported by the Vice President for Financial Operations and the Treasurer, the total financial operations of the Institute, including sponsored research, increased from the level of 1975-76. Education and general expenses — excluding the direct expenses of departmental and interdepartmental research, and the Lincoln Laboratory — amounted to $117,057,000 during 1976-77, compared to $110,259,000 in 1975-76. Reflected in the finances of the Institute was the decrease in the use in operations of unrestricted funds to $5,801,000, compared with $6,493,000 in the preceding year.

The direct expenses of campus departmental and interdepartmental sponsored research increased from $72,916,000 to $77,804,000, and the direct expenses of the Lincoln Laboratory's sponsored research decreased from $84,517,000 to $80,503,000 because of a decline in subcontracts and outside purchases.

The construction program of the Institute continued to

make progress in 1976-77 with the book value of educational plant facilities increasing from $201,823,000 to $203,340,000.

At the end of the fiscal year, the Institute's investments, excluding retirement funds, students' notes receivable, and amounts due from educational plant, had a book value of $332,706,000 and a market value of $401,096,000. This compares to book and market totals of $319,878,000 and $401,006,000 last year.

GIFTS

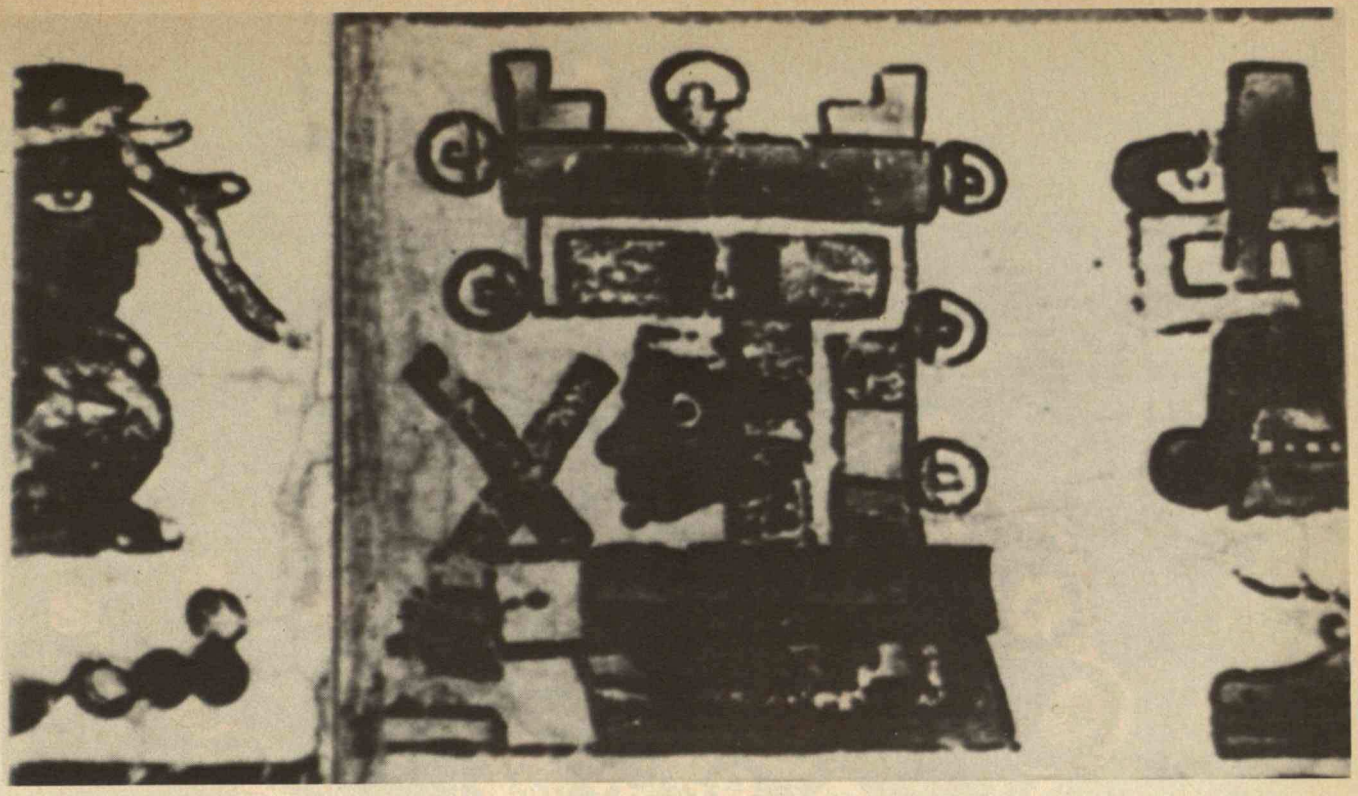
Gifts, grants and bequests to M.I.T. from private donors increased from $22,393,000 in fiscal year 1975-76 to $26,899,000 in fiscal year 1976-77. The latter figure includes unrestricted direct gifts to the Alumni Fund of $1,970,000 which constituted part of the total of $4,851,000 reported by the Alumni Fund in 1976-77.

PHYSICAL PLANT AND CAMPUS ENVIRONMENT

Completed during the year was the restoration of Bexley Hall, a major rehabilitation effort which included the renovation of all bathrooms and kitchens, replacement of basic electrical and mechanical systems, and the general upgrading of living space. With the assistance of the Safety Office, the sprinkler systems were expanded in East Campus dormitories, Eastgate Married Student Apartments, and Tang Residence Hall. Also completed was a 4,000 gross square foot addition to the Cancer Research facility in the Seeley G. Mudd Building.

Currently under construction are a 13,000 gross square foot interim animal care facility on Vassar Street between the Cyclotron (Building 44) and the Parsons Laboratory for Hydrodynamics (Building 48); renovations to Huntington Hall (10-250) and to the first floor of Building 10 for an Alumni Center, Exhibition Hall, and Electric Power Systems Engineering Laboratory (EPSEL); and in the Sloan Automotive Laboratory (Building 31), a major combustion research facility — a significant addition to the Energy Laboratory's research program. Included in this latter facility is a horizontal combustor capable of burning fossil fuels at the rate of 10,000,000 BTU/hr. Construction is also under way on a new outdoor track, field, and game facility expected to be completed in the fall and to be known as the Henry G. Steinbrenner (Class of 1927) Stadium.

As part of a continuing effort to bring the arts to the campus, a Henry Moore sculpture and a Tony Smith sculpture were installed, the former within the area of Killian Court and the latter sited at the west end of the campus adjacent to the Westgate residential complex.



A figure of possible astronomical significance taken from the Codex Bodley. The codex was painted by the Mixtec Indians of central Mexico in about 1520 A.D., just before the Spanish conquest. Like other codices, it is a book of sorts, or more precisely a set of pages linked like the folds of an accordion. A typical codex would have ten or more such pages, with each page containing four tiers of perhaps ten pictographs. In sum, then, the codex would contain several hundred images arranged in sequence. Mixtec codices, unlike those of Maya origin, are entirely pictographic; they contain none of the more symbolic hieroglyphs, except for the occasional identification of a human figure by a symbol otherwise used to represent a day in the Mixtec calendar. The Indian shown in the illustration is part of an image perhaps three-quarters of an inch tall. He is given no name, but he appears to be a priest, looking out from the window of a temple. The light-bulb-like figures studding the temple are thought to represent stars; and the priest appears to be using crossed sticks as a collimating device to aid him in his observation of something at the horizon.

The problem of interpreting a symbol such as crossed sticks is shared by a number of even less certain cases. Among these is the claim that a Mesoamerican shadow clock is represented in a hieroglyphic figure which decorates the temple of Venus at Xochicalco in Central Mexico (see the figure on page 48). The glyph itself consists of a quartered disk surmounted by a sort of crown; the crown in turn consists of two interlocking arches perpendicular to each other. As for the interpretation of all this, the disk has elsewhere been identified as a figure of the sun; the "crown" in other contexts seems to refer to a calendar year. The identification of a sundial is made despite the absence of any indication that Mesoamericans were ever interested in dividing the day.

I doubt that further examples are necessary to establish the difference between Old and New World evidence regarding the use of instruments in ancient astronomy. Clearly each site offers distinct challenges, yet more than a few scholars in the field have decided that the interesting challenges exist in the Old World and not in the New. It is true that the Mesoamerican material does not yet seem to contain a critical mass of clues. But as investigators turn in greater number to the study of New World astronomy, there is an increasing chance that mutually supportive conclusions will converge to create a coherent picture of astronomical activity by the ancient Americans.

For further reading:

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"The Astronomical Origin of the Theory of Conic Sections," by Otto Neugebauer, *Proceedings of the American Philosophical Society,* **92,** 1948, 136-38.

"The Water Clock in the Tower of the Winds," by J. V. Noble and D. J. Price, *American Journal of Archeology,* 72, 1968, 345-55.

Gears from the Greeks, by Derek J. de Solla Price, Science History Publications, 1975.

"The Caracol Tower of Chichen Itza — an Ancient Astronomical Observatory?", by A. F. Aveni, S. L. Gibbs, and H. Hartung, *Science,* **188,** 1975, 977-85.

"Astronomical Signs in the Codices Bodley and Seldon," by H. Hartung, in *Native American Astronomy,* A. F. Aveni, editor, University of Texas Press, 1977.

"Crossed trapezes: A pre-Columbian astronomical instrument," by A. Digby, in *Mesoamerican archeology: New Approaches,* N. Hammond, editor, University of Texas Press, 1974.

Sharon Gibbs is a historian of science currently employed by the National Archives. Her research interests and publications have emphasized the topics discussed in this article: early scientific instruments in the Old World and developing astronomy in the New; among her publications is a book, *Greek and Roman Sundials.* She received her B.S. in mathematics from Colorado State University, and her Ph.D. from the Department of History of Science and Medicine at Yale University, and has served as a Smithsonian Postdoctoral Research Fellow at the National Museum of History and Technology.


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Sirius Enigmas

Ancient records suggest that Sirius was red, not blue-white, two thousand years ago. If so, the accepted notions about how stars evolve may have to be revised. And that's just one of the mysteries surrounding the brightest star in the sky.

Kenneth Brecher
M.I.T.

Sirius is the brightest star in the sky: it is about twice as bright as any other visible star. This prominence suggests that it has been well observed by astronomers and others ever since people began observing the sky, and an examination of ancient records confirms that this is so: Sirius was an important celestial object for several ancient cultures. In Babylonian cuneiform texts dating from 1000 to 500 B.C., the star is called KAK.SI.DI. The Babylonians identify it as part of a constellation which they describe as a bow and arrow; for them, Sirius was a star marking the tip of the arrow. The Chinese independently described a bow and arrow in the sky, but they used different stars for their construction. For them, Sirius was part of the image at which the arrow is shooting; and curiously, the image at which that arrow is aimed is a dog. In Western tradition, Sirius is part of the constellation Canis Major, the Big Dog. It is remarkable that the same images — dogs, bows and arrows — occur in the cosmographies of different cultures; after all, if you look at the sky, you see only points of light on a dark field. Hertha von Dechend and Giorgio di Santillana, in their book, *Hamlet's Mill*, take this as an indication that the astronomical myths of China and Mesopotamia derive from a common origin.

Sirius was also prominent in Egyptian culture. In fact, it was perhaps one of the strongest influences upon the scientific, agricultural, and religious lives of the ancient Egyptians. The Egyptians of 3000 B.C. worshipped it for the following reason: Sirius was the star whose first heliacal rising each year — that is, its first annual rising just before the sun on the eastern horizon — occured just prior to the flooding of the Nile. Thus the heliacal rising of Sirius each spring presaged the Egyptian agricultural cycle. We are not surprised to find that the Egyptians built temples to include alignments with Sirius (such as the small temple of Isis erected in about 700 B.C.). Even in the New World, Sirius seems to have played a prominent cultural role, being incorporated in the design of the Bighorn medicine wheel (see John A. Eddy's article earlier in this issue) and in the street layout of the ancient city of Teotihuacan in Mexico.

My own interest in Sirius derives from my hope that one can learn astrophysics from history. It has happened before. Many of us in high-energy astrophysics consider the Crab Nebula, for example, to be our Rosetta Stone: a key, not to ancient myths, but to modern physics. The Crab Nebula is the remnant of a supernova explosion, and near its center lies a pulsar, a pulsing radiation source reliably believed to be a rotating neutron star. Much of what we know about the astrophysical origin of cosmic rays, synchrotron radiation, and heavy elements derives

The celestial neighborhood of Sirius is shown in a representation from the *Uranometria*, a catalog of the sky published by Johann Bayer in 1603. Sirius itself is α Canis Majoris, the brightest star in the Great Dog, and indeed the brightest star in the sky; it appears here as the prominent star covering all of the dog's snout. The stippled region behind and to the left of Canis Major's head is part of the Milky Way. The constellation appearing at the lower right of the illustration is Columba, the dove.

from our knowledge about the Crab Nebula, and much of what we can deduce from observations of the Crab Nebula is aided by knowing that the supernova explosion that created it was recorded in 1054 A.D. by Chinese astronomers, and perhaps by Southwest American Indians (see John C. Brandt's article). Now Sirius, as I will show later in this article, might be called the Rosetta Stone of normal stellar astronomy — the study of rather normal stars that have never exploded but have gently shriveled up and are fading away. Accordingly, anything that ancient civilizations can teach us about Sirius is likely to be useful in understanding the late stages of stellar evolution.

Another motivation for studying the ancient references to Sirius — or for studying archeoastronomy in general — is essentially a negative one: over the past few years, writers such as Erich von Däniken have achieved a great deal of popularity by suggesting that the ancients cannot possibly have known as much as they apparently did about astronomy, unless they had help from aliens in U.F.O.s. Let me give a hypothetical example of the specious sort of reasoning one might apply to Sirius. There is a number which shows up repeatedly in ancient numerology called the Golden Mean. For modern mathematicians, it is the solution to the equation $x - 1 = 1/x$. Alternatively, it is derived by constructing a Fibonacci series — a progression of numbers beginning with 1, in which each number is the sum of the preceding two. Thus the series is 1, 1, 2, 3, 5, 8, and so on. As the numbers of the series approach infinity, the ratio of the last two numbers approaches the Golden Mean. Whatever its derivation, the Golden Mean is $(1+\sqrt{5})/2$, or about 1.61. Various shells in nature are constructed on the basis of the Golden Mean; the spiralling shell of the chambered nautilus, for instance, conforms to the law generating the Fibonacci series.

The Greeks and Egyptians considered the Golden Mean a mystical quantity. They also considered geometrical representations of the Mean to be pleasing to the eye, for the sides of the Parthenon are constructed on the ratio of 1.61 to 1. The ratio of the base to the height of some Egyptian pyramids is said to be the same. Now I have already said that the Egyptians were very interested in Sirius. I have not yet said that Sirius is actually a binary star system in which the visible star is accompanied by an essentially invisible companion — a second star which cannot be seen without powerful telescopes. The eccentricity of its orbit (a mathematical term denoting its deviation from circularity) happens to be about equal to the inverse of the Golden Mean.

But is the reader inclined by these circumstances to suppose that the Egyptians built their pyramids in conformity with the orbital eccentricity of the invisible companion to Sirius? And did the Egyptians, lacking powerful telescopes, receive this knowledge from creatures of another world? I don't think so. The earthly sources of the Golden Mean seem to be more probable. Of course, the derivation of the Golden Mean in any fashion requires ingenuity. And thus our study of ancient astronomy cannot help but increase our respect for the intelligence of our predecessors — even if they *didn't* know about the companion to Sirius.

With all this as background, I propose to discuss two mysteries surrounding the brightest star in the sky: one historical, the other mythological. The first of these mysteries is the following: beginning about 1000 B.C. and continuing through about 200 A.D., Sirius was said to be red by every writer who wrote about the matter. Now if you go outside and look at the brightest star in the sky you will find that Sirius is white, or perhaps blue-white. It surely isn't red like Mars. Nor is it red like the stars that actually *do* look reddish: Aldebaran, Betelgeuse, Antares, Arcturus and Pollux. Perhaps, you might say, there is no puzzle in this: Sirius was red then and blue-white now. The problem is that, so far as any astrophysicist can understand, there is no theory of stellar evolution that will make Sirius change from red to blue-white in 2,000 years.

With fear, therefore, for the tenability of accepted theories of stellar evolution, let us examine the ancient evidence. In a Babylonian cuneiform text dating from about 700 B.C., one finds a reference to the star "KAK.SI.DI. rising in late autumn and shining like copper" — or so it says in the translation I have read. I myself do not know how this translation comes about. I do know that language in general is riddled with ambiguity; for instance, the Russian work *krasnoy* can mean "red" or "magnificent." Thus you cannot know the meaning of the word unless you know the context in which it appears. Accordingly, I'm not sure what to make of a star that "shines like copper." The phrase might indicate that Sirius had the color of copper — or perhaps the brilliancy of polished copper.

What did the Egyptians have to say about Sirius? Unfortunately, the Egyptians were inclined more to astrology than to astronomy; there is little of any sort to be gleaned about quantitative stellar astronomy from their writings. In particular, although the Eygptians watched Sirius with intense interest (it is the only star explicitly named in any of their records), they have left no surviving references to its magnitude, its color, its changing position, or any other physical property.

In the time of the Romans, the astronomical record is more extensive. Sirius is sometimes called the Dog Star, and sometimes it is called "rubra-canicula," the red dog. I don't think there can be any ambiguity in the translation of that latter expression. In addition, there are the references to Sirius by Seneca, a sharp observer who seems to have interpreted astronomical observations more correctly than Aristotle; he knew, for example, that comets were not an atmospheric phenomenon, and explicitly wrote that they must orbit the sun. In reference to Sirius, Seneca reported that "the redness of the Dog Star is deeper, that of Mars milder, that of Jupiter nothing at all." The translation seems unambiguous.

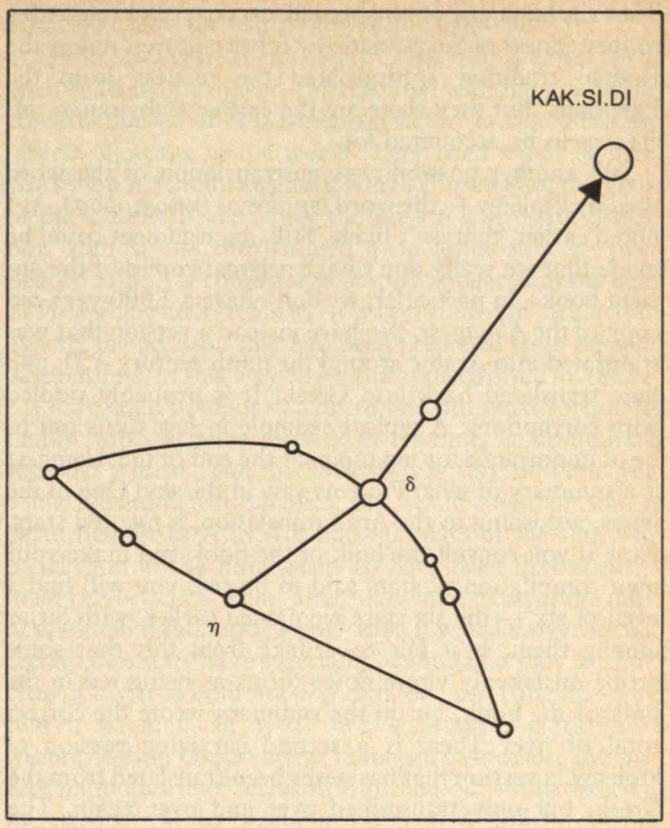
Then there are the writings of many other Roman and Greek authors, Pliny, Cicero, Horace, Ovid, Hesiod, Homer, and Virgil among them: they all call Sirius red in one way or another. But the evidence that makes the strongest impression derives from Ptolemy, perhaps the greatest astronomer of antiquity. In about 150 A.D. Ptolemy recorded most of the Greeks' knowledge of astronomy in his book *He Mathematike Syntaxis*, later

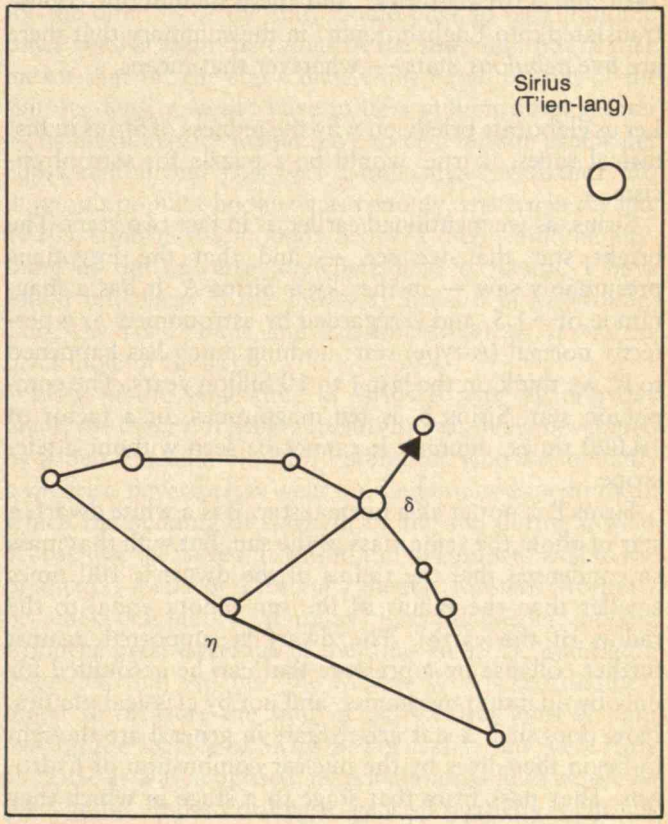
translated by the Arabs under the name *Ho Megas Astronomos* ("The Great Astronomer"). In the ninth century the Arabs further corrupted the title, changing the Greek "Megas" to "Megiste," adding the article *al,* and finally transforming it to *Almagest*, the name under which the book is known to us today. The *Almagest* includes a set of tables listing over a thousand stars, most of which were first studied and catalogued by Hipparchus in about the year 133 B.C. Several characteristics of the stars are given, and among these characteristics is color. In particular, six bright stars are called red: Aldebaran, Betalgeuse, Antares, Arcturus, Pollux — and Sirius. The first five of these are in fact the brightest red stars in the sky; all can be seen quite easily today, and all are reddish to the eye; they all fall into the category of stars known to modern astronomers as red giants.

But what about the sixth? Could the astute and clear-minded Ptolemy have made a mistake? And if not, why should Sirius be called red 2,000 years ago? One possible reason is that some prestigious ancient writer made a dreadful mistake about the color and all subsequent scholars followed suit. After all, some happenings of that sort are famous: it appears, for instance, that no one of authority counted the teeth in a horse's mouth after Aristotle gave the incorrect number. Still, I don't think that anything similiar could have happened for the color of Sirius because the references in question are Greek, Roman, and Babylonian: that is to say, they derive from a long period of history and many different cultures. It is hard for me to believe that the mistake could be perpetuated very long, with Sirius so prominent in the sky.

Another possibility is that the ancient observers looked at Sirius only when it was rising and near the horizon. Light rays reaching an observer at such an angle undergo a fair amount of reddening, and so Sirius presumably would have looked red until it had risen higher in the sky. (Note, for example, that Venus looks red in the photograph on page 31, which accompanies the article by John A. Eddy.) Now if that was all there were to this explanation, it would be a pretty feeble one. After all, why should the ancients have looked at Sirius only when it was near the horizon? Moreover, at the latitude of Alexandria, where Ptolemy wrote, the star α Centauri never rises more than a few degrees above the horizon. Why doesn't the *Almagest* describe α Centauri as red?

There is a clever idea that will obviate many of these problems; it was mentioned to me by Philip Morrison but I subsequently found that the 19th-century Italian astronomer Giovanni Schiaparelli had thought of the same thing a hundred years earlier. The idea is the following: There is in fact only one star in the sky that is bright enough to be seen as a reddened star on the horizon. That star is Sirius. (In the words of Tennyson, ". . . the fiery Sirius alters hue/And bickers into red and emerald. . ." The Arab poet Ibn Alraqqa wrote: "I recognize Sirius shining red, whilst the morning is becoming white./The night, fading away, has risen and left him./The night is not afraid to lose him, since he follows her.") Since the Egyptians were interested in Sirius at its heliacal rising, it is therefore natural that they should have called it red.





The stars in the vicinity of Sirius, as grouped into constellations by the Babylonians (top drawing) and the Chinese (bottom drawing). In both cultures, the stars are construed as composing a bow and arrow. For the Babylonians, however, the arrow is relatively long, and Sirius is at its tip. By contrast, the Chinese made Sirius the target at which the arrow is aimed. Indeed, the Chinese were specific about the nature of that target: they called Sirius a "celestial jackal," T'ien-lang.

That explanation, of course, fails to cover the references to the redness of Sirius made by other cultures, unless the Roman tradition appropriated the redness from the Egyptians. But then there are the earlier, Babylonian references to be accounted for.

Still another possibility is mistranslation of the word used by Ptolemy — the word *hipokeros* (υποκιρροσ). As I noted earlier, that isn't likely. Still, an argument could be made that we really don't have original copies of the ancient books. In particular, we don't have a 2,000-year-old copy of the *Almagest*. We have instead a version that was translated into Arabic around the ninth century A.D. and then translated back into Greek. It is probably riddled with corruptions. A typical example in fact turns out to be of importance for my topic: at the end of the *Almagest* is a summary of what Ptolemy saw in the sky. One of the items, according to the Arab translation, is *five* red stars. Now if you consult the bulk of the book and make your own compilation of stars said to be red, you will find a total of six — the six stars we named earlier, with Sirius among them. Is it fair to deduce from this that some scribe mistakenly wrote down Sirius as being red in the bulk of the book, but in the summary wrote the correct total of five? There is a second surviving version of Ptolemy, a version that has never been translated from the Greek, but only transcribed over and over again. The copies that we have of this second version date from the 14th and 15th centuries. And these manuscript copies, translated into English, report in the summary that there are five *nebulous* stars — whatever that means.

Let us elaborate briefly on why the redness of Sirius in historical times, if true, would be a puzzle for astrophysicists.

Sirius, as we mentioned earlier, is in fact two stars. The bright star that we see — and that the Egyptians presumably saw — in the sky is Sirius A. It has a magnitude of −1.5, and is regarded by astronomers as a perfectly normal (A-type) star: nothing much has happened to it, we think, in the last 1 to 10 billion years. The companion star, Sirius B, is ten magnitudes, or a factor of 10,000 times, dimmer. It cannot be seen without a telescope.

Sirius B is not at all a normal star. It is a white dwarf: a star of about the same mass as the sun, but with that mass so condensed that the radius of the dwarf is 100 times smaller than the radius of the sun (about equal to the radius of the earth). The dwarf is supported against further collapse by a pressure that can be accounted for only by quantum mechanics, and not by classical physics. How does such a star arise? Stars in general are thought to begin their lives by the nuclear combustion of hydrogen. They pass from that stage to a stage in which they burn helium, and in doing so they expand into what are called red giants. Eventually the giant's atmosphere of helium is blown off or otherwise consumed. What remains is a white dwarf. Now the lifespan of a red giant is thought to be tens of millions of years, and the blow-off time during which a red giant becomes a white dwarf and cools to the presumed temperature of Sirius is also thought to be a truly astronomical time: say a million years. Accordingly, if Sirius looked red to the ancients because Sirius B, a white dwarf now, was a red giant only 2,000 years ago, all theories of stellar evolution would have to change.

How then does an astrophysicist approach the problem of why Sirius was said to be red? Here are the possibilities that come to mind: first of all, the astrophysicist might conclude that it simply *wasn't* red; it was blue-white. After all, that's the most acceptable astrophysical explanation.

In the second place, it is possible that a dust cloud passed in front of Sirius roughly 2,000 years ago. There are in fact dust clouds in interstellar space and they do filter light in such a way that objects behind them appear to be redder. Of course the objects would also appear to be dimmer, but Sirius is so bright that even if it lost two or three magnitudes, it would still be a first-magnitude star. One wonders, though, where the dust cloud is now.

A third possibility is that Sirius B was a red giant a million years ago — say in pre-Neanderthal times. I think many astrophysicists would reluctantly allow that. If so, one could claim (with every anthropologist in the world convulsed by laughter) that the Neanderthals observed

Source	Reference
Egyptian glyphs (ca. 2800 B.C.)	*"Sothis [Sirius], herald of the new year and the flood"*; no explicit color reference.
Babylonian cuneiform text (ca. 700 B.C.)	A star called KAK.SI.DI "shines like copper."
Aratus (ca. 270 B.C.)	ποικίλοσ (*poikilos*, or "colored").
Cicero (ca. 50 B.C.)	*Rutilo cum lumine* ("with ruddy light").
Horace (ca. 10 B.C.)	*Rubra canicula* ("red dog").
Seneca (ca. 25 A.D.)	*Acrior sit Caniculae rubor, Martis remissior, Jovis nullus.* ("The redness of the Dog Star is deeper, that of Mars milder, that of Jupiter nothing at all.")
Ptolemy (ca. 150 A.D.)	υπόκιρροσ (*hipokeros*, or red, coppery, yellowish) used for Aldebaran, Betelgeuse, Arcturus, Antares, Pollux (all currently red stars) and Sirius.
Al Sufi (ca. 980 A.D.)	Red stars include all those named by Ptolemy except Sirius.
Ulugh Beigh (ca. 1450 A.D.)	Red stars include all those named by Ptolemy except Sirius.

Ancient references to the color of Sirius. Explicit namings of red span a millennium, from a Babylonian cuneiform text to the Greek astronomer Ptolemy. All seem agreed that the Dog Star is red, but this is distressing, for the star is blue-white today, and modern theories of stellar evolution cannot account for it being a different color in historical times.

the sky, recorded the fact that Sirius was red, and passed down that fact in a tradition that lasted a million years. It doesn't seem very likely.

A fourth possibility is that Sirius B was indeed a red giant 2,000 years ago. If so, its magnitude would probably have been −3 to −8. It would have been a spectacular star, visible even in the daytime, and that would surely explain why so many different cultures were interested in it. On the other hand, I repeat that one simply cannot get the transformation from red giant to white dwarf to work in 2,000 years — not even with all the latest possibilities envisaged for subatomic physics by theoretical physicists. In particular, a 2,000-year transformation would seemingly leave the surface temperature of Sirius B at about a million degrees Kelvin or more — far higher than its recently-measured temperature of 30,000 °K.

A fifth possibility is that mass transferred from Sirius A to Sirius B. This happens, for example, in novae — two-star systems, it is now thought, in which a star seemingly explodes over and over again because it keeps receiving mass. To be sure, it is highly unlikely that mass transfer could have occurred in the Sirius system, for those stars are relatively far apart as binary star systems go. Yet if it had in fact occurred, Sirius B might temporarily have become a red giant of sorts, or actually what I would call a slow nova. Examples are known of stars that have made similar detours from normal stellar evolution, such as F G Sagittae or Eta Carina.

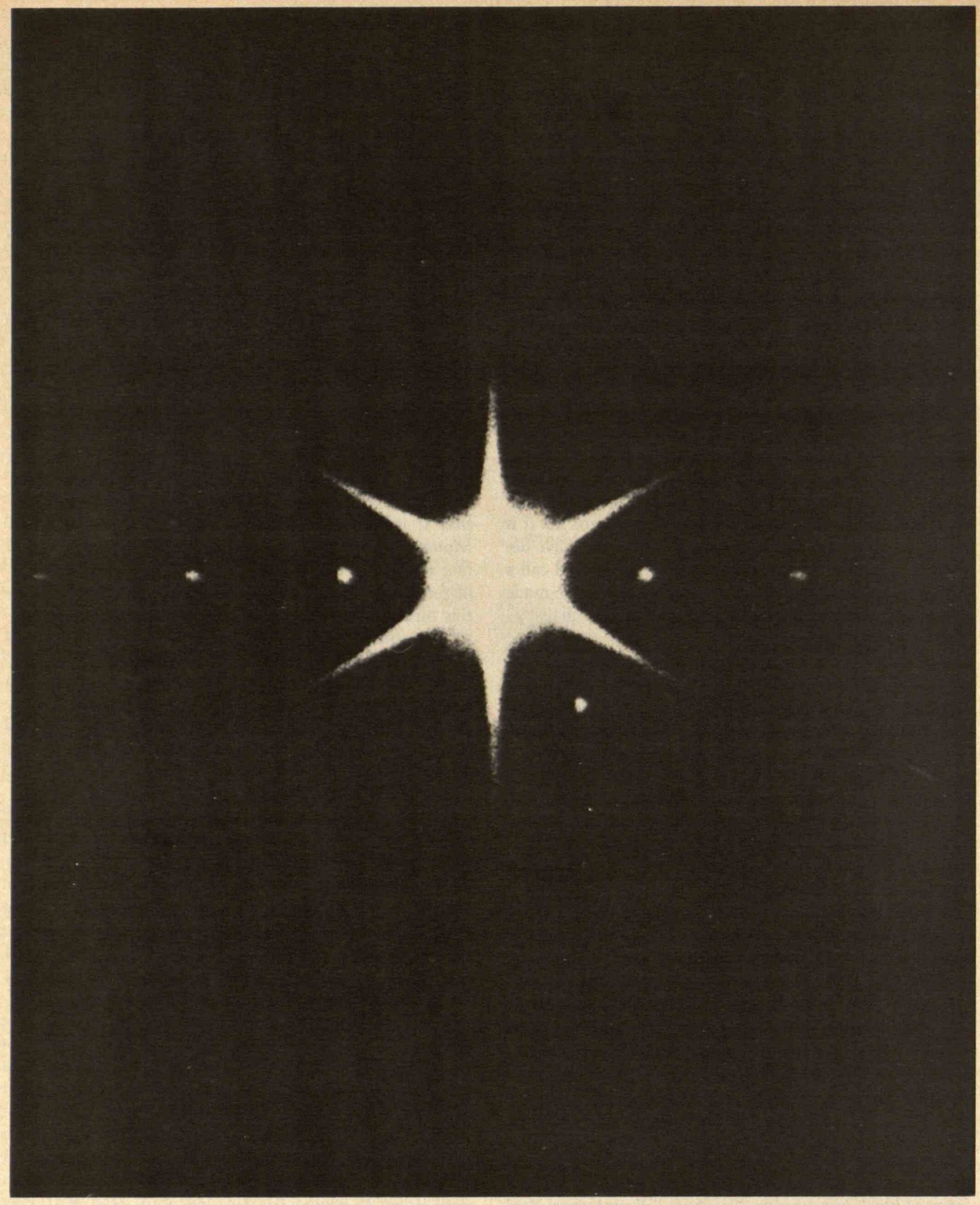
Sirius has played a prominent role in stellar astronomy and physics over the past 200 years. In 1710, for example, Edmund Halley compared the various star positions he had measured with those measured 1,500 years earlier by Ptolemy and decided that Sirius, Arcturus, and Aldebaran were in the wrong places in the sky. They were wrong by about a degree — twice the diameter of the sun. Halley could hardly think that Ptolemy could have made so big an error. Therefore, he concluded, the stars must move amongst each other.

A much more subtle finding came in 1836, when Friedrich Bessel made a careful study of the motion of Sirius. (Bessel is best known as the mathematician who developed Bessel functions, but he did so as an aid to his astronomical researches.) Bessel determined that Sirius was moving against the background of stars at the rate of about one arc-second per year, but that it was wriggling sinusoidally as well, with a maximum amplitude of 11 arc-seconds and a period of about 50 years. From this he concluded that an invisible companion star was (and is) perturbing the visible star's trajectory. About this star he wrote a famous letter to Alexander Von Humboldt — a letter relevant, no doubt, to all people who espouse the cause of black holes today. "I adhere," Bessel wrote, "to the conviction that [the stars] Procyon and Sirius form real binary star systems consisting of a visible and an invisible star. There is no reason to suppose luminosity is an essential quality of cosmical bodies. And visibility of countless stars is no argument against the invisibility of countless others." In short, the absence of evidence, claimed Bessel, is not the evidence of absence. He started what he called the astronomy of the invisible.

About 20 years later, Alvan Clark, the greatest 19th century telescope maker, collaborated with his son on the construction of an 18½-inch refractor, at that time the largest telescope in the world. They tried it out at their workshop in Cambridgeport, Massachusetts, on the bank of the Charles River where the Boston University Bridge now stands; and they trained it on Sirius as it set over Beacon Hill. A second star promptly appeared in the field of view right next to Sirius — a very dim star, situated in exactly the position that had been predicted from Bessel's calculations. In this way Sirius B was discovered in 1862.

I have tried without success to find out what sort of attention this discovery received at the time. It should have received a great deal, for Sirius B was very dim and yet, using Newtonian mechanics, one could calculate that it perturbed Sirius A as if it had the mass of the sun. The conclusion at the time seems to have been that Sirius B must be very cool. That, after all, would explain the dimness — and it did, until 1910, when it was discovered that certain dim stars have spectra indicating that they are hot. Now if a star is both hot *and* dim, one can conclude only that it is small. In 1914, Walter Adams, working at Mount Wilson Observatory, managed to measure the surface temperature of Sirius B. It turned out — incorrectly, in retrospect — to be about 8,000 °K. It followed from this measurement that the radius of Sirius B, to account for the dimness of the star, would have to be a hundred times smaller than the radius of the sun; and that in turn meant that for the star's mass to be equal to that of the sun, its density would have to be a million times greater — its mean density would have to be a million grams per cubic centimeter. This was astonishing. Sir Arthur Eddington's popular books on astronomy, written in the late 1920s, confirm that nobody believed there could be anything in the universe anywhere near so dense. I have found references in the 1920s to Sirius B in *Le Monde*, The New York *Times*, and *Scientific American*. It was the black hole of its day.

Now at the same time as Sirius B was creating this furor, the theory of general relativity was being developed by Albert Einstein. In 1919, Eddington, who was actually a theorist, nevertheless went on the famous expedition in which the bending of starlight by the sun during a solar eclipse was measured. It was found to conform well to the prediction made by Einstein's theory. Einstein promptly became a cult hero — about as big as the Beatles, judging from the press coverage at the time. In 1925, Eddington suggested that Adams (the Mount Wilson astronomer) ought to measure the shift in the spectral lines of light leaving the surface of Sirius B. For if that star were truly as dense as was supposed, its gravitational field would be prodigious. And according to general relativity, light has a hard time escaping from a strong gravitational field — a hard time that finds expression in a shift of spectral lines toward the red. Adams did measure the red shift, and found it to be in good agreement with the calculation made by Eddington. Moreover, it agreed with the tiny radius attributed to the star. Here then was a true mystery for astrophysicists: Sirius B did in fact have an unbeliev-



Sirius as it appears in a powerful telescope. The bright, six-pointed image at the center of the photograph is the very same Sirius that can be seen with the unaided eye. Actually, however, this object is Sirius A, for "Sirius" has been known since 1862 to be a binary star system. The companion star, Sirius B, is too dim to be seen with the unaided eye; here it appears below and to the right of Sirius A. The other points of light in the photograph, strung out in a horizontal line at either side of Sirius A, are all artifacts. They were generated by placing a fine-wire grating in front of the telescope's objective lens, and are used for positional calculations that cannot be made with the bright, fuzzy image of Sirius A itself. Finally, the six points radiating from Sirius A are artifacts as well. They were generated by a hexagonal diaphragm placed in front of the objective lens, and serve to channel the light of Sirius A in such a way as to leave areas of blackness in which Sirius B and the innermost two artifactual points can be seen. The photograph was taken by Irving W. Lindenblad at the U.S. Naval Observatory.

able density. How was this possible? Nearly a decade after the mystery arose, it was finally solved: R. H. Fowler, in one of the first applications of quantum mechanics to a macroscopic system, showed in 1925 that the new physics could indeed allow a star to exist at a density of a million grams per cubic centimeter by providing so-called "degeneracy" pressure — without analog in classical physics — to support it against further gravitational collapse.

I come now to the second enigma surrounding Sirius — a mythological enigma. It concerns a tribe in Africa called the Dogon, which lives in what is now Mali but was called the French West Sudan 50 years ago. In any event, the tribe lives near the city of Timbuktu, and directly on an African trade route from Egypt to West Africa. European contact with the Dogon seems to have been limited to the arrival of an occasional missionary, at least until the early years of the 20th century. Beginning in the 1930s, however, two French anthropologists, Marcel Griaule and Germaine Dieterlen, lived with the tribe for over 20 years. As time went on they gained the tribe's confidence. Indeed, after about 20 years Griaule was so highly regarded that the tribe decided to tell him their deepest secrets. Accordingly, the tribe picked four old chiefs to tell Griaule about the Dogon's cosmology — their knowledge of the stars. The four informants were Innekouzou Dolo, a woman between 65 and 70 years of age, priestess of Amma and soothsayer, who spoke the Sanga language; Manda D'Orosongo, 45-year-old priest of the Binou Manda, who spoke the language Wazouba; Yébéné, 50-year-old priest of the Binou Yébéné, who spoke Sanga; and Ongnonlou Dola, between 60 and 65 years old, patriarch of the village of Go, who also spoke Sanga.

What did the Dogon know about the sky? In the first place, the informants told Griaule that Sirius is at the center of their mythology. And then, drawing on the ground with a stick, they showed him that Sirius was not at all a single star; it was two stars. Indeed, to quote Griaule and Dieterlen: "[the visible Sirius] is one of the foci of the orbit of a tiny star called Digitaria, potolo, or the star of the Yourougou, Yurugu tolo, which plays a crucial role, and which, unaided as it were, hogs the attention of male initiates." Note (from the illustration on page 62) that the Dogon placed Sirius A at the focus of an ellipse, not at the center of a circle. The ellipse represents the orbit of Digitaria, the invisible companion star; and that companion orbits Sirius A in a period which, counted twice by the Dogon (for a reason having to do with the primacy of a concept of twin-ness in the Dogon worldview), is 100 years. Further still, Digitaria was said by the Dogon to be the beginning and end of all things; and because of this role the star is considered to be the smallest thing in the sky — and also the heaviest. Digitaria, reported Griaule and Dieterlen, "consists of a metal called sagala, which is a little brighter than iron and so heavy 'that all earthly beings combined cannot lift it.' "

Griaule and Dieterlen were also told that the earth rotates around the sun, that Jupiter has four satellites, that Saturn has rings not like the ring occasionally seen around the moon, that the planets all move around the sun, and that they always do so in elliptical rather than circular orbits! The problem for us, therefore, is how the Dogon could have known a host of astronomical facts, all of which are invisible to the unaided eye. In particular, how could they have known about the existence of Sirius B? How could they have known of its incredible density? its elliptical orbit? its 50-year period? They have no business knowing any of this.

The most obvious possibility is the dreadful thought that it's all just a fake. When Griaule died, he was so much a member of the tribe that about a quarter of a million Dogon gathered and held a state funeral. He was the only outsider ever so honored. Maybe this was his last joke. I am told, however, by Hertha von Dechend that both Griaule and Dieterlen performed scrupulously honest research; they weren't even flamboyant people, so one cannot accuse them of trying to achieve notoriety with their spectacular story. The journal article in which they report their findings is certainly sober enough.

A second obvious possibility is that somebody told the Dogon all about Sirius before Griaule and Dieterlen ever arrived. The sequence of events, as imagined independently by Carl Sagan, Ian Roxborough, and myself, might run as follows. As I've tried to emphasize, Sirius B was important and widely disseminated news in the 1920s. Some Jesuit priest reads about it in *Le Monde,* and then goes to Mali long before Griaule and Dieterlen.

"Tell us your myths," say the Dogon.

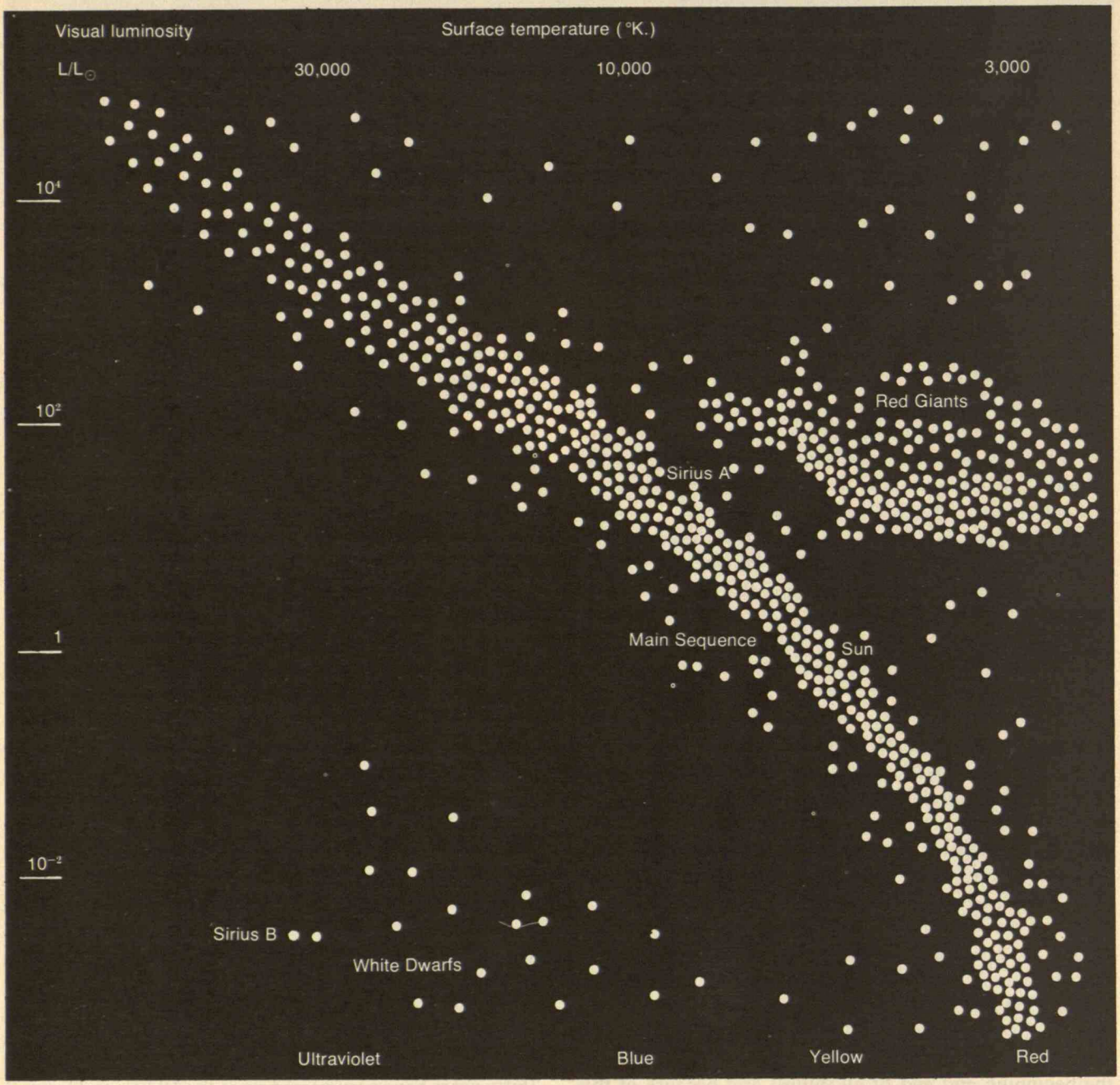
"Do you see that star?" replies the priest; "it is actually two stars, and the invisible star is the heaviest thing there is."

The Dogon promptly incorporate this information into their culture. And when the two anthropologists are told the secrets of the Dogon, all they get is a cross-cultural translation. Now it seems to me that this is no doubt the most likely explanation for the knowledge possessed by the tribe. It counts in favor of this explanation that the Dogon say there is a third member of the Sirius system, a third star that orbits Sirius A in the same sense and with the same period as Sirius B. There were occasional reports of a third star in Sirius throughout the 1920s. It was the last time at which the separation between Sirius A and Sirius B was maximal: 11 arc-seconds. Accordingly, many astronomers were looking at Sirius. About half a dozen of them reported in the technical literature that they had seen a third star. Some astronomers even computed an orbit and a period for this so-called Sirius C, and claimed to be able to find its perturbations upon the visible Sirius A. None of this was ever confirmed, and yet, of course, our imagined Jesuit might have passed it on to the Dogon. (Fifty years have now passed since the 1920s, and Sirius A and Sirius B again are separated by 11 arc-seconds. About five years ago, I.W. Lindenblad, an astronomer at the U.S. Naval Observatory, tried to find the third star. He couldn't. Moreover, he couldn't find any perturbations in Sirius A beyond those caused by Sirius B.)

I am told by anthropologists that cultural transfer of the sort I am supposing could not possibly have hap-

pened; there is no chance, they say, that missionaries, ethnographers, and the like could have smuggled modern notions into the core of a sacred tradition, which is what a cosmology is. I wonder about their certainty, though, for one can point out several examples in which cultures change wholesale. Consider the Cargo Cults of the South Sea Islands. After World War II, these islanders built large straw airplanes, hoping to lure the great birds from the sky — the birds which no longer were bringing them the products of "civilization." The straw airplanes are the central element of their religion. Consider, too, the cultural changes caused by a single man, D. Carleton Gajdusek, who received the 1976 Nobel Prize in medicine for his work on slow-acting viruses of the brain.

When Gajdusek visited various tribes in New Guinea in the course of his researches, he carried with him a microscope. Each tribe would tell him a different theory for the origin of disease. Then Gajdusek would show the tribe some bacteria, or perhaps an amoeba. Gajdusek wrote an article about his anthropological findings, and some Aus-



The nature of stars is displayed on a Hertzsprung-Russell diagram, in which a star's surface temperature is plotted against its visual luminosity. (The luminosity of our sun is taken as unity.) A so-called main sequence runs from the upper left to the lower right of the chart; massive stars tend to be more luminous and have higher surface temperatures, placing them toward the left of the sequence. After a star consumes its hydrogen, it leaves the main sequence and expands into a red giant, a hundred times as bright as the sun but redder in color. The star now burns helium. Eventually, though, the red giant phase ends: the extended outer envelope of the star is blown off or otherwise lost, leaving behind a hot, dense star called a white dwarf. All of these events are thought to occur on a time scale measured in millions of years. Sirius A and Sirius B are placed on the diagram in accordance with their observed colors and visual luminosities. Sirius A, a main sequence star, is about ten thousand times brighter than Sirius B, a white dwarf.

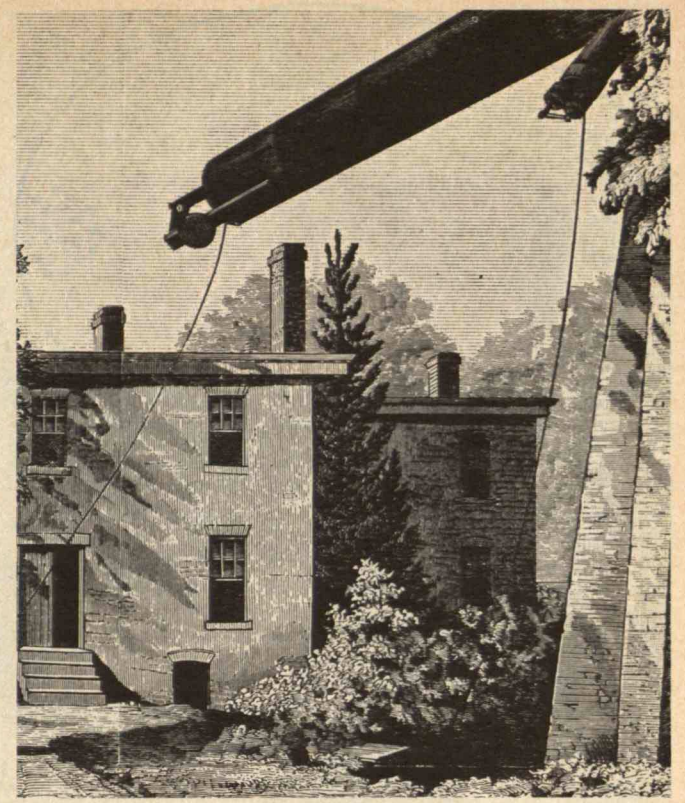
tralian anthropologist decided that it was incorrect: all the tribes, the anthropologist thought, ought to have the same idea about disease. To test his conviction, he followed the trail of Gajdusek and interviewed the tribes that Gajdusek had studied. Each tribe *did* give a single theory — the theory that Gajdusek had taught them. Gajdusek himself tells the story that one night in New Guinea he and a Russian scientist sang for their dinner. They sang a Russian song, "Black Eyes." Some years later, Gajdusek chanced on a recording of the tribe's songs. Among them was one sounding suspiciously like "Black Eyes."

Suppose, despite all this, that cultural transfer is somehow ruled out — as it would be if it turned out that someone had visited the Dogon prior to about 1910 and had found their mythology to include Sirius B. Even then, the Dogon might have been told about its 50-year period —but not about its incredible density. It would be a great mystery how they could have known this latter fact. One possible explanation is that the Dogon traded heavily with the Egyptians. There are in fact many similarities in their cultures. It may then be that the Dogon got the information from the Egyptians at some time in the past. Of course, that would only push the essential question backward in time: for how, then, did the Egyptians know that Sirius was a binary system that includes a white dwarf? One obvious solution to the problem is discussed in a book, *The Sirius Mystery,* written by a man named Robert Temple, who spent eight years of his life working on the Dogon mystery. The theme of Temple's book is summed up by the following question, posed on the jacket of the book: "Was Earth visited by intelligent beings from a planet in the system of the star Sirius?" The case he makes for an affirmative answer to this question is even less credible than the arguments advanced for ancient extraterrestrial visitors by Erich von Däniken. For if visitors from Sirius had bothered to set down on earth, they should at least have had the courtesy to relay to the lucky greeting party the intelligence that Jupiter has at least 14 moons (not four), and that Uranus (as well as Saturn) has rings — half a dozen of them (a fact discovered only this year by earthly astronomers).

I am still convinced that cultural transfer, say from a Jesuit priest, is a likely explanation for the knowledge possessed by the Dogon. But if that explanation were disallowed, I would offer two final possibilities. The first of them concerns sheer probabilities. Suppose there are a thousand cultures in the world. Suppose further that anthropologists study all of those cultures. Each one of them has myths. Most of the myths conflict with scientific theory; a few do not. We are dealing here with the myth that is most nearly correct by our standards of truth.

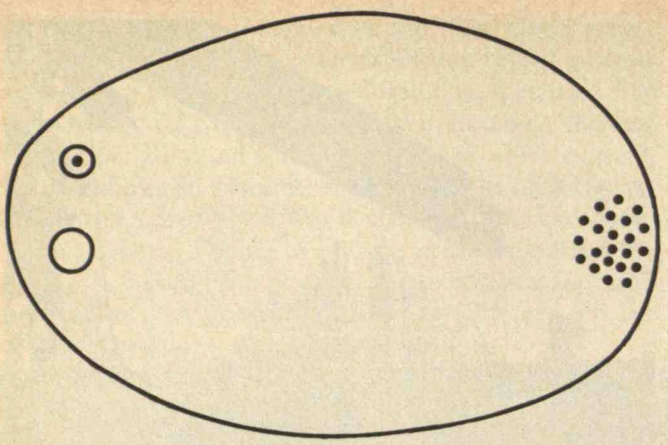
This argument is not very satisfying, of course, when one asks how likely it is for the Dogon, *ex nihilo,* to have postulated a 50-year period, an elliptical orbit, and an immense density — all for an invisible star. I'd like to quote, however, from two accounts of a similarly unlikely achievement.

The first account appears in *Gulliver's Travels,* written by Jonathan Swift in the 1750s. Gulliver, in the section



Alvan Clark's workshop ("Clark and Sons' Observatory") on Henry Street in Cambridgeport, Massachusetts. In the foreground are a telescope mount and tube which were used for testing objective lenses; the Clarks made the largest lenses in the world. While testing an eighteen-and-a-half-inch objective — indeed the largest in the world at that time — the Clarks discovered Sirius B, the nearly invisible companion star to Sirius A. The lens itself was to have gone to the University of Mississippi, but the Civil War intervened. Harvard College then wished to purchase it. The ready cash of the University of Chicago won out. The Chicagoans paid $11,187 in 1863.

from which I quote, is visiting Laputa, a small island suspended in air by a giant lodestone. Among the population are great astronomers who meditate a great deal about the universe. "The lodestone," reports Gulliver, "is under the care of [these] astronomers, who from time to time give it such positions as the monarch directs. They spend the greatest part of their lives in observing the celestial bodies, which they do with the assistance of glasses far excelling ours in goodness. For although their largest telescopes do not exceed three feet they magnify much more than those of a hundred amongst us and at the same time show the stars with greater clearness. This advantage hath enabled them to extend their discoveries much further than our astronomers in Europe. They have made a catalog of ten thousand fixed stars whereas the largest numbers of ours do not contain above a third of that number. [This is an accurate remark about the state of European astronomy in 1750.] They have likewise discovered two lesser stars or satellites which revolve about Mars, whereof the centermost is distant from the center of the primary planet exactly three of the diameters and the outermost five. The former revolves in the space



The Dogon's understanding of the binary star system Sirius, as drawn on the ground with a stick by elders of the Dogon tribe of the Mali Republic. The open circle at the left is the star known to astronomers of our own civilization as Sirius A; it is a prominent star, easily visible to the unaided eye. Above it, and represented as a dot within a circle, is a star not visible to the naked eye that the Dogon call Digitaria; it is shown, according to the Dogon, in its position nearest the visible Sirius. The cluster of dots near the right edge of the ellipse, again according to the Dogon, is Digitaria at its greatest excursion away from its visible companion. Digitaria is evidently depicted as a set of dots in this latter place in order to represent a "twinkling" that the Dogon attribute to the star at that point in its orbit.

of ten hours and the latter twenty-one and a half, so that the squares of their periodical times are very near the same proportion with the cubes of their distance from the center of Mars. Which evidently shows them to be governed by the same law of gravitation that influences other heavenly bodies."

Now Mars does indeed have two moons: Phobos and Deimos. They were discovered only a century ago — a century after Swift wrote *Gulliver's Travels.* The actual periods of Phobos and Deimos are 7.5 hours and 30 hours. How did Jonathan Swift do so well? A clue can be found in an equally striking passage in Voltaire's *Micromegas:* "In one of those planets which revolve around the star named Sirius" writes Voltaire, "there was a young man of much wit with whom I had the honor to be acquainted during the last visit he made to our little anthill. He was called Micromegas, a name very well suited to all big men. . . . When they left Jupiter they crossed a space about a hundred million leagues wide and passed along the coast of Mars, which as we know is five times smaller than our little globe. They saw two moons which serve the planet and which have escaped the attention of our astronomers."

The source of these remarkable guesses by Swift and Voltaire appears to be contained in a letter from Kepler to Galileo more than a century earlier: "I am so far from disbelieving," wrote Kepler, "in the existence of the four circumjovial planets that I long for a telescope to anticipate you, if possible, in discovering two round Mars (as the proportion seems to me to require), six or eight round Saturn, and perhaps one each round Mercury and Venus." The point is that Kepler evidently felt that the satellites (as well as the planets) should be arranged according to some geometric progression. One should not forget, by the way, if one wishes to become a scholar of coincidences and lucky guesses, that Voltaire's Micromegas hailed from an immense satellite of Sirius.

The last possible explanation of "The Sirius Mystery" is a broad and implausible one, lying in the realm of astrophysics. Its sole merit is that it accounts both for the ancient report of Sirius as red and for the Dogons' knowledge of Sirius B. Suppose that about 2,000 years ago Sirius B was indeed a red giant, so that in consequence Sirius A and Sirius B were roughly comparable in brightness. As they moved around each other, one would see a single point of light, but its color might change over a period of 50 years. If the red star dominated during your lifetime, you would call Sirius red. If you saw the colors changing you might say that there were two stars. In any case, you would learn of a 50-year cycle. And as the red disappeared, you might also decide that the star is growing old and shrivelling up. By this argument, you might be led to believe that the second star, now invisible, is very dense. All of this may have been part of Egyptian cosmology, passed on to the Dogon, where it is preserved today.

Even with such a scenario, the redness of Sirius would create an incredible problem for theoretical astrophysicists, whose understanding of stellar evolution comes as much from computer calculations as from observations of the sky. It's my secret hope, nevertheless, that Sirius truly *was* a red star in historical times. I would much prefer to learn stellar evolution from the ancient myths of man than from the modern myths of the computer.

For further reading:

Ancient Astronomy in General: Four books are recommended: *Hamlet's Mill,* Giorgio de Santillana and Hertha von Dechend, Gambit Press, Boston, 1969; *The Dawn of Astronomy,* J. Norman Lockyer, M.I.T. Press, Cambridge, 1973; *The Exact Sciences in Antiquity,* Otto Neugebauer, Harper Brothers, New York, 1962; and *Science Awakening II: The Birth of Astronomy,* B. L. van der Waerden, Oxford University Press, New York, 1974.

The Red Color of Sirius: This problem has been discussed many times over the last thousand years. Early investigations are summarized in Alexander von Humboldt's book, *Cosmos,* vol. III, 131-136, Harper Brothers, New York, 1851. T.J.J. See (whose life-story, entitled *Brief Biography and Popular Account of the Unparalleled Discoveries of T.J.J. See,* offers as its motto: "The Simple Truth — The Best Inspiration to the Youth of the Land") summarized many more arguments in the *Astr. Nach.,* **229,** 245, 1926. The astrophysical problem has been discussed by H. M. Johnson in *A.S.P. Leaflets,* 383, 1961, and by Zdenek Kopal in *Close Binary Systems,* Wiley & Sons, New York, 1959.

Dogon Astronomical Myths: M. Griaule and G. Dieterlen, "Un Systeme Soudanais de Sirius," *Journal de la Société des Africanistes,* **20,** I, 273, 1950, is the original article on the Dogon's knowledge of Sirius. More recent interest seems to have been kindled by two articles by W. H. McCrea in the *Journal of the British Astronomical Association* **84,** 63, 1973 and *Quarterly Journal of the Royal Astronomical Society* **13,** 506, 1972. Finally, a lively correspondence concerning the Dogon Sirius myths has appeared in the pages of the British magazine *The Observatory,* **95,** 52, 1975; **95,** 215, 1975; and **97,** 26, 1977.

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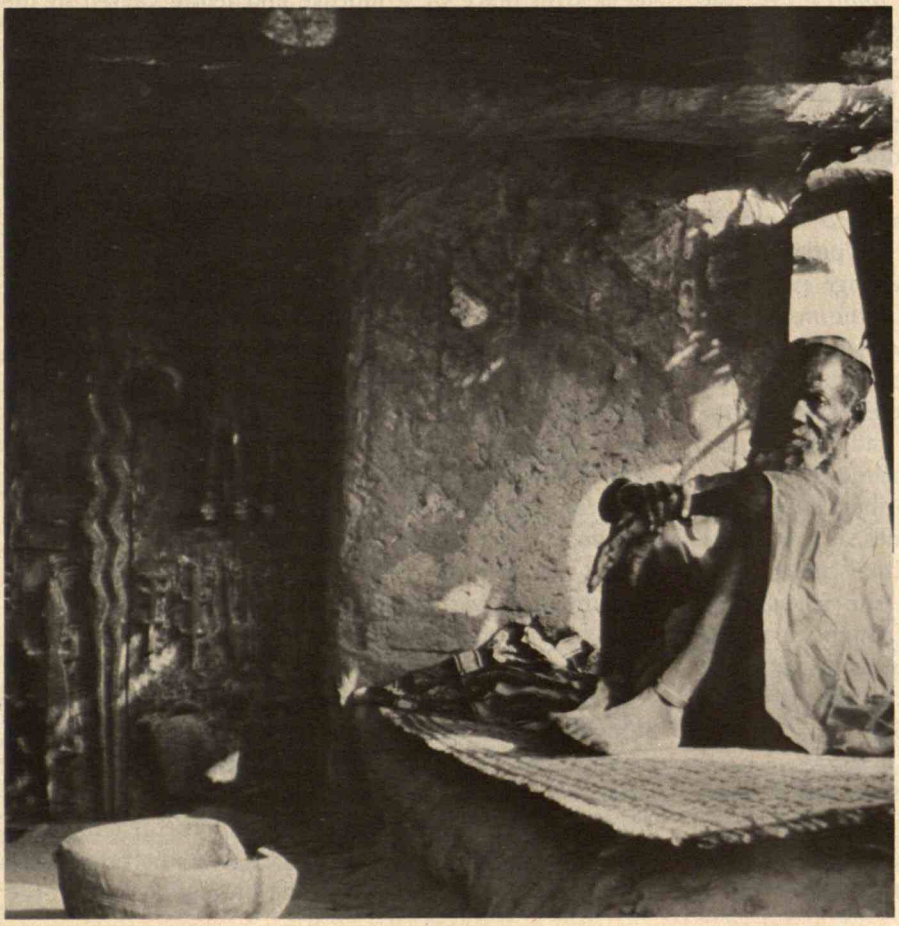

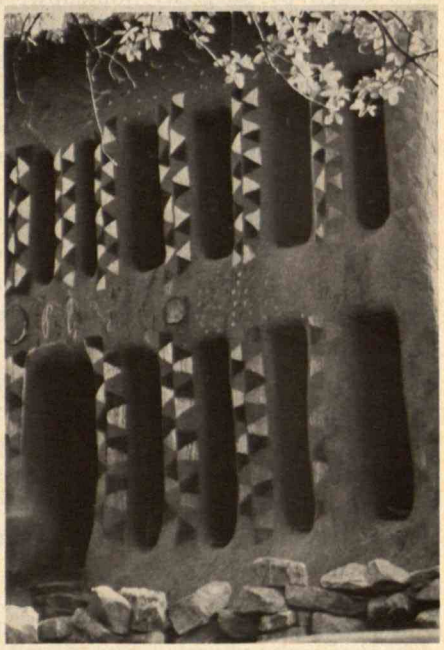

Four views of the Dogon civilization. The two photographs at the top were taken by Jay M. Pasachoff, an astronomer at Williams College, during a visit to West Africa occasioned by a total solar eclipse. The hogon (priest) and his temple were photographed by Kenneth Strzepek, a graduate student in M.I.T.'s Civil Engineering Department, in the course of a water-conservation project in which he participated.

The Basic Astronomy of Stonehenge

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The stark, majestic circle of stone may be an ancient monument erected on the site of a still more ancient observatory.

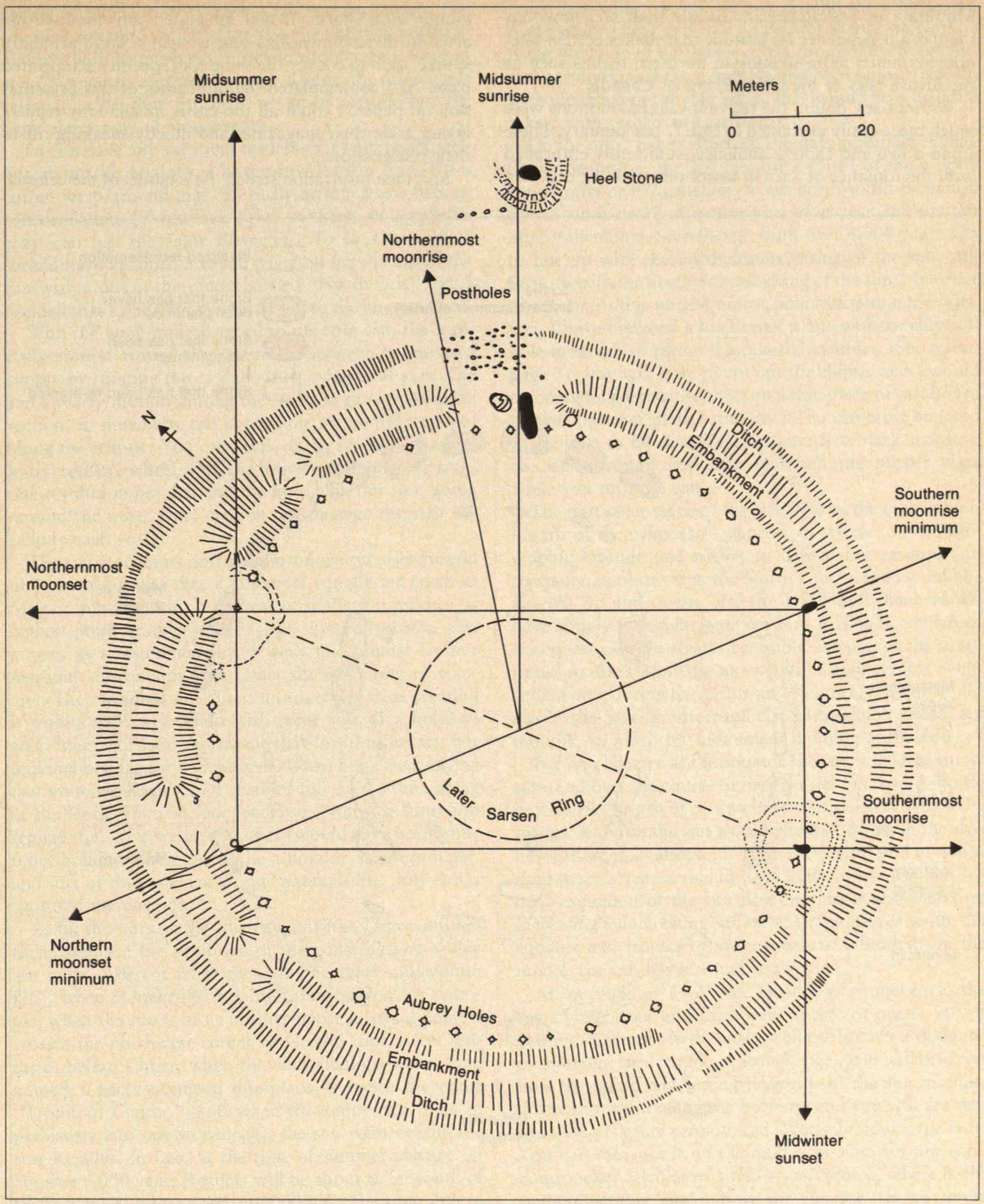
About twenty years ago, when I first saw Stonehenge, I was taken by surprise. Somehow, in mind's eye, the trilithons and stone circle had assumed truly monumental proportions. In contrast, the real stones were set on a disappointingly small scale. My confession is not intended to belittle the world's most famous megalithic site, but simply to report an honest reaction to one of the most romantic of all prehistoric ruins.

My initial response, that Stonehenge seemed unexpectedly small, is in fact relevant to the viewpoint that I should here like to defend: that Stonehenge is not so much an ancient megalithic observatory as the *monument to an earlier observatory*. By this I mean that any astronomical sighting lines at Stonehenge must have been well established centuries before they were fossilized into such a heavy, immobile configuration, and that the organization of the monumental stones is primarily dictated by the aesthetic symmetry along their principal axis and not by a secondary series of lunar sightlines, as some have proposed. At best, Stonehenge was a ritual center commemorating bygone discoveries, not a site where new knowledge of the heavens was actively sought. It was a stable monument to the eternal order and regularity in the sky, and as such its alignments still synchronize with the sun's rhythmic march through the seasons.

The statistics of Stonehenge are impressive enough. The stone ring, about 30 meters in diameter, originally comprised 30 megaliths capped by 30 lintels. Within this so-called sarsen circle stood the five huge trilithons in a horseshoe pattern; each was a pair of uprights with a lintel held in place by a mortise and tenon carved in the stone. The largest of the megaliths, one of the trilithon uprights, must have weighed 50 tons; it is the largest prehistoric hand-worked stone in Britain. By comparison, the stones of the sarsen ring are a mere 25 tons each. The sarsen stones — originally huge natural boulders but dressed by pounding with stone hammers — came from the Marlborough Downs, nearly 20 back-breaking miles north of Stonehenge.

Today nearly half of the sarsen ring has been quarried away, and only three of its stones remain untouched in their original positions. However, 16 are now in place and six have regained their lintels with an assist from the archaeologists. The trilithons have escaped the ravages of time somewhat more successfully. The two southeast groups never fell. When the largest group, on the central axis, tumbled down in ages past, one of the stones broke in two; the surviving upright has apparently been replaced two or three meters too close to the center of the monument. Nevertheless, the original orientations of the rings and the outlying, so-called Heel Stone, about 80 meters to the northeast, can be established reasonably well.

Before we can understand the unique geometry of Stonehenge and the special orientations of other ancient monuments, we must grasp a basic idea about the cyclic motions of the sun, moon, and stars. I shall use Stonehenge as a specific example, but the general rules will apply whether the monument is at the latitude of Teotihuacan in Mexico, Karnak in Egypt, or Moose

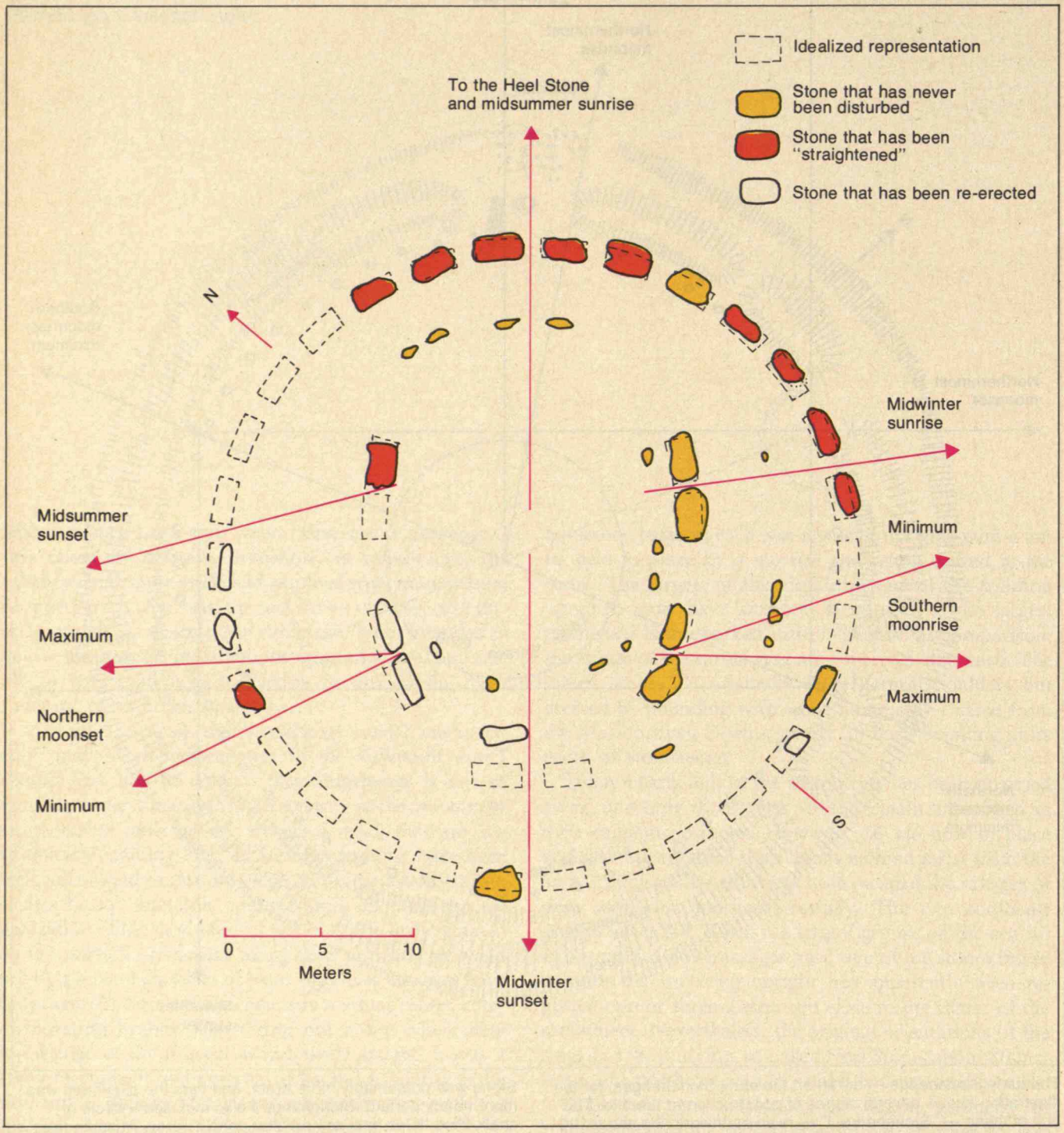


The early Stonehenge — or rather, the early Stonehenges, for the illustration shows several stages of construction at the site. The first of these — "Stonehenge I" — is an earthwork ring about 100 meters in diameter and two meters high. Its completeness was broken (as of about 2400 B.C.) by a single gap directed in the approximate direction of an outlying marker called the Heel Stone; and in this gap, excavation has uncovered a grid of postholes: the remains, it seems, of an effort to mark the northernmost excursion of the moon. Note that the Heel Stone lies slightly away from a line drawn from the center of the earthwork ring to the horizon point marking the midsummer (solstitial) sunrise; in 2400 B.C. the Heel Stone was presumably more erect, and thus the alignment was more nearly perfect. Stonehenge I also included a circle of chalk-filled holes now named after John Aubrey. At some later time, Stonehenge II was added. It comprises two mounds of earth, covering some of the chalk-filled holes, and also the so-called station stones. As shown in the illustration, these additions to the site mark out the corners of a rectangle whose sides and diagonal align with various risings and settings of the sun and moon. In about 2100 B.C., Stonehenge III was constructed at the center of the site (shown by the circle of dashes). Stonehenge III is the megalithic structure that draws our attention to the site today.

Mountain in Saskatchewan. As we shall see, however, there is a dependence on latitude that makes certain phenomena much more striking in northern realms such as the British Isles or the Great Plains of Canada.

Without any doubt, the relevant celestial motions were much more easily explained at M.I.T. last January. There I had a live and captive audience, sufficiently enthralled with the romance of ancient astronomy to have braved a winter snow storm. It was far easier, too, to wave my arms in three dimensions and to spin a large armillary sphere, than to convey the same concepts on a flat printed page. As I contemplated the difficulties of this presentation on paper, I could all too easily imagine my readers laying aside their magazines and quietly sneaking off to their refrigerators.

And then inspiration struck. As a model of the celestial



The later Stonehenge — Stonehenge III. Dotted lines show what one time stood at the site: a horseshoe of five trilithons within a ring of 30 sarsen stones. Eighty meters from the center of the ring is an outlying marker, the Heel Stone; in combination with the central trilithon, it marks the central axis of the monument. The illustration shows several putative alignments of the monument to various risings and settings of the sun and moon. The two solstitial alignments associated with the central axis are far less problematical than the alignments associated with the off-center trilithons. The illustration fails to show the various fallen stones and fragments. Yet no rock of any size was originally present: the soil beneath the grassy surface is exclusively chalk.

sphere, a cylindrical cola can is a fair approximation. The celestial equator, which splits the sky into its northern and southern hemispheres, nicely girdles the can. Cocked at a 23° angle to the equator is the ecliptic, the other great celestial circle that concerns us when considering the basic astronomy of Stonehenge.

To convince any skeptical readers that I am really serious about this analogy, I have provided (on page 70) a cutout wrap-around that can easily be taped to a beer or soft drink can. (If you lack either of these, a Campbell's soup can has the same diameter.) To be thorough, I should have included a round paste-on for the top of the can with a dot in the center labeled "North Pole," but I decided that some things could be left to the imagination.

With the wrap-around taped to the cola can, the sun's daily motion around the celestial sphere can be imitated simply by rotating the can about its cylindrical axis. The sun's *yearly* motion among the stars, in the opposite direction, is shown by the succession of monthly images along the ecliptic. You can think of the sky as a giant celestial roulette wheel, with the heavens spinning eastward one revolution per day and the little ball, our sun, going around the other way, making one passage through the ecliptic each year.

The sun reaches its northernmost position near the end of June, but notice that it is almost equally far north in May or July. By our present calendar the sun reaches its highest point around June 21, the summer solstice, also known as midsummer day. It isn't midsummer by our seasonal conventions, but rather the *beginning* of summer. The arrival of the sun at this northernmost position is traditionally associated with some sort of a holiday; and Philip Morrison assures me that July 4 is, in fact, our national holiday for midsummer. When I objected, saying that everyone knows the Fourth of July marks the signing of the Declaration of Independence, Professor Morrison replied that "if it weren't so, there would have been some other holiday. There *has* to be a holiday at midsummer, and just at this moment in our national life, July 4 has captured the position."

As for the stars on the cola-can universe, I have omitted them, because the positions of the constellations today are quite different from those in the third millennium B.C., when Stonehenge was built. Nowadays, for example, when the sun is at its northernmost solstitial point it crosses the northwest corner of Gemini. But a few centuries before Christ, when the constellations were being named, Cancer occupied this place — hence the name "Tropic of Cancer." And when the anonymous men of prehistory laid out Stonehenge, the sun went nearby the star Regulus, in Leo, at the time of summer solstice. In another 9,000 years Regulus will be about as far south of the equator as it was north in 2000 B.C. The slow shift in the constellations is called precession. As a consequence of this shift, the zodiacal figures last matched their present positions 26,000 years ago, and during the next 26,000 years they will cycle all the way around the ecliptic and come back to their current coordinates. It follows that the rising direction of a bright star is a comparatively ephemeral orientation. If the pyramids had been built to line up with the rising of the star Sirius, they would now be quite askew with respect to that star.

On the other hand, although the stars gradually change their orientation, the 23° (almost 24°) tilt of the ecliptic stays pretty nearly constant, so the north-south excursion of the sun is nearly the same year after year, millennium after millennium. Stonehenge, built over 4,000 years ago to line up with the northernmost rising of the sun, still lines up with the northernmost rising of the sun.* In order to see *where* this northernmost point lies along the horizon, I have designed a horizontal plane with an elliptical hole in which to rotate the celestial cylinder. (See insert, page 71; you will have to cut out the ellipse, and I would recommend pasting the sheet on a thin piece of cardboard to give a greater planar stability.) The can must be tilted in the hole to fill the ellipse exactly; two black strips on the wrap-around will help maintain the proper slant while you turn the can.

The particular slope of the hole — and the corresponding tilt of the cylinder — depend, of course, on the geographic latitude one wishes to depict. For example, to represent an observer at the North Pole, the can would be straight up and down, and the horizontal plane would have simply a circular hole cut into it. The sky north of the equator would always be visible, the part to the south never, so that clearly the sun would be in the visible hemisphere only during the spring and summer; the sun would circle the sky uninterruptedly throughout those six months. So much for monument building at the Pole.

For an observer at the equator the can would be on its side, and over the course of the year the sun would shuttle between 23° north of east and 23° south of east in its daily risings. At noon the sun would always be high in the sky, never more than about 23° from the zenith; and at noontime twice a year it would be directly overhead. The annual excursion of the sun becomes larger and therefore increasingly interesting as an observer moves from the equator and tropics to more northern latitudes. On the model, the can has less and less tilt.

At an angle of 51.2° (the latitude of Stonehenge) the sun swings back and forth over an arc of nearly 90°. If you rotate the can in the cut-out ellipse (which is designed to represent the latitude of Stonehenge), you will discover how the rising and setting positions of the sun oscillate north and south along the horizon, and you will see that the swing is quite pronounced. Precisely how large is it? You can measure it on the model, or you can put it on your pocket calculator: $\sin D = \sin \delta / \cos \varphi$, where δ, the sun's maximum angle above the equator (its maximum declination) is about 23.5° and the latitude φ is 51.2°. The maximum deviation D from the east-west line is just about 40°.

Enough for the basic mathematics. Let us next apply a thought-experiment to prehistory.

Ancient man, living on the island that is now called

* In fact, the tilt of the ecliptic *does* change slowly, and the reason the sun still lines up so well at Stonehenge is that the Heel Stone has tended to tip over in the correct direction.

Britain, must have been aware of the rising sun's endless excursions back and forth along the horizon. Eventually someone must have marked by trial and error the direction of the northern rising of the summer sun. How fascinating, then, to watch day after day on some later year as the sun worked its way toward its northern limit. On each successive day the sun would take a smaller step than the day before, preventing any intuitive extrapolation. Would the sun reach the same limit? Or would it go beyond? What an exciting discovery to find that each year the sun reached *exactly* the same northernmost alignment! The weather might vary in a capricious manner, but the sun had a faithful regularity. Surely a discovery worth a monument!

The grand edifice at Stonehenge indeed points to the northernmost rising of the sun, for from the center of the stone ring, the sun can be seen to rise above the Heel Stone at the time of June solstice. In some of his more dogmatic moments, the distinguished archaeologist of Stonehenge, R. J. C. Atkinson, has denied this, and he was made to look rather silly several years ago when a C.B.S television crew filmed the sun rising majestically past the Heel Stone at the summer solstice. Still, the sun in truth rises to the left of the Heel Stone and moves to a position above the tip of that boulder. Hence, as Atkinson correctly claimed, the shadow of the Heel Stone cannot fall into the center of the ring at the solstice. In 2000 B.C. the sun would have risen a degree farther north than it does now, because the tilt of the ecliptic does vary slowly. Probably, though, the Heel Stone was more upright then; and in any event, a sightline of only 80 meters from Heel Stone to the center of the sarsen circle means that the observation is not very precise: the sunrise would appear almost the same for a week before and after solstice. Certainly for ritual purposes the principal axis of the monument points to the rising sun at the summer solstice. By symmetry the opposite direction points southwest, to the southernmost setting of the sun at the winter solstice.

The real question about Stonehenge is, does it point to anything else? More specifically, would it have required a Stone Age Einstein to think of asking whether the *moon* also had a northernmost rising point? I am not sure. What would have been needed for investigation of the moon was a sufficient time free from the exigencies of food gathering. But a special sort of curiosity would have been necessary as well. Each month, in one phase or another, the moon will rise once in the vicinity of the Heel Stone, yet in general this alignment will not be very exact. It thus could be ignored as one of the vagaries of that fickle object. Furthermore, not all of these risings would be visible; the solar brilliance at midsummer would overpower a thin crescent rising soon after the sun, for instance. Finally, because the moon moves about 30° a day, it could skip past the very northernmost position on any given cycle.

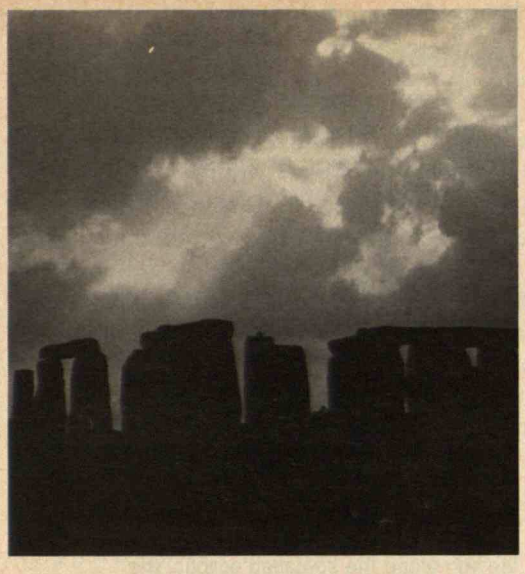
The reason that the moon's northernmost rising is only in the vicinity of the Heel Stone, and not dead on, is that the moon's path is askew to the sun's. (If it were not, there would necessarily be a lunar and solar eclipse every month.) The moon's path in fact cuts the ecliptic at two opposite points in the sky, and wanders off by 5° north of the ecliptic on one side of the sky, then 5° south on the other. Moreover, the place where the maximum wandering occurs is slowly changing. Hence the moon's path can go 5° north of the 23.5° northernmost point of the ecliptic, but nine years later it will go 5° south of this northernmost point. In the first situation the moon would move in the sky between 28.5° north and 28.5° south, and in the second between only 18.5° north and 18.5° south. With the handy formula we used earlier in this article, we get an extreme swing along the horizon of 50° north of east, well past the Heel Stone. But nine years later, we find that the moon at most would rise only 30° north of east. In other words, our Stone-Age astronomer would not only have to have the insight to ask if the moon, like the sun, had a northernmost rising, but he would also have needed plenty of time to be sure — 18 years to complete the observation of just one complete cycle.

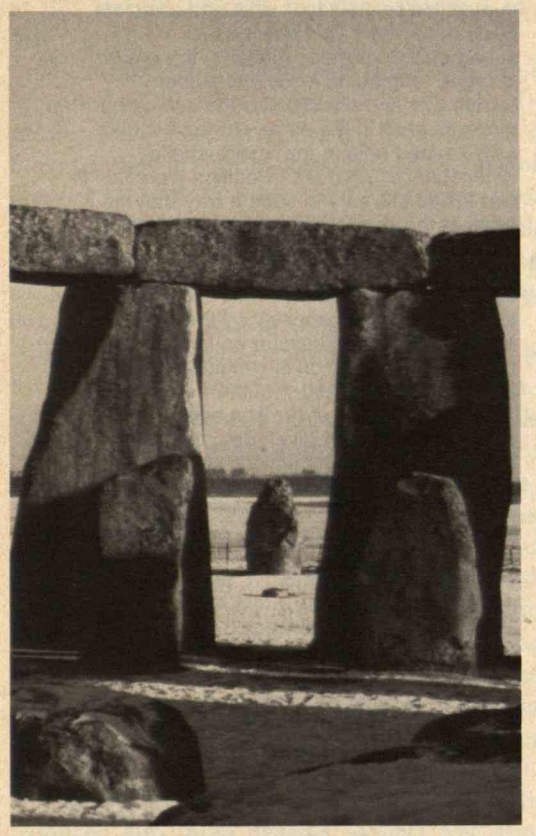
Would it be easy to think of trying this? I don't know, *but we can be rather sure that it was done.* Excavations at Stonehenge have revealed a series of post holes at angles northward of the Heel Stone in just the positions we would expect if someone was trying to establish the moon's northernmost limit by trial and error.

In its earliest stages the Stonehenge site was surrounded by an embankment approximately two meters high and about 100 meters in diameter. This earthwork ring had one entrance, in the general direction of the Heel Stone, but not symmetrically aligned with it. The opening was just wide enough to accommodate the post holes lined up with the northernmost excursion of the moon. Because similar grids are found at other neolithic sites, there is good reason to suppose that these represent lunar alignments.

Gerald Hawkins, who more than anyone else has drawn attention to the astronomical nature of Stonehenge, claims that solar and lunar alignments can also be associated with the four trilithons flanking the main axis of the monument. These are shown on page 66, where the megaliths are represented as idealized rectangles. The idealized representation is in itself instructive, because we notice at once that not all the sightlines would be possible on account of the awkward slanting views required. To be sure, the actual megalithic boulders are more roughhewn, so the sightlines are in fact feasible. Yet it gives pause to me, at least, to suppose that a grand edifice of this sort was specially designed so that the sightlines would depend on the imperfections or asymmetrical sizes of the rocks. I would also worry if the southern moonrise extremes and the northern moonset extremes were megalithically marked, and not the other pair of events (northern moonrise and southern moonset).

Up till now I have virtually ignored one important historical aspect of the Stonehenge site: the monument we now admire is Stonehenge III, built around 2100 B.C.; the sarsen ring and trilithons stand in the center of a much larger and older site whose development occurred hundreds of years earlier. And it is the early Stonehenge that has a greater claim as a research observatory, if for no other

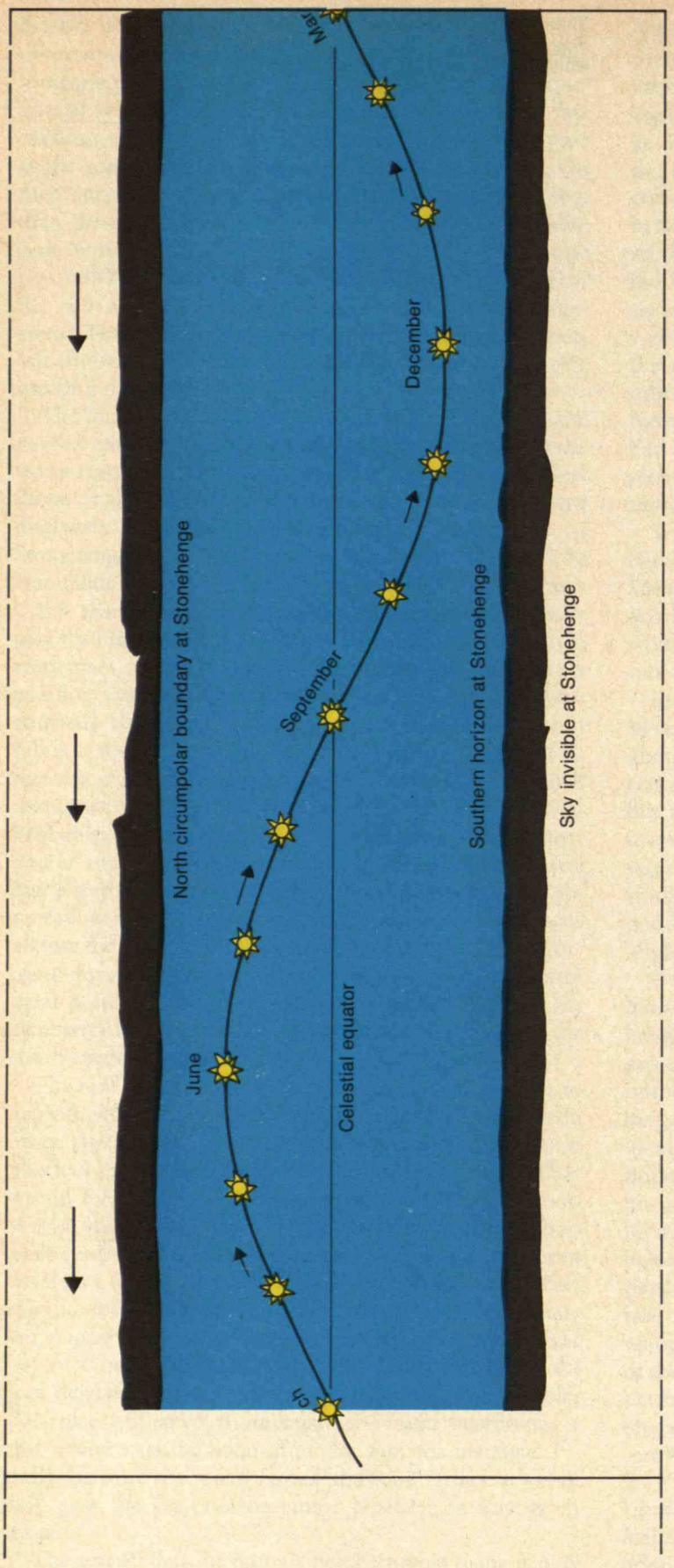




Top: Stonehenge from the east. The photograph was taken by the author in 1958; since then, some further reconstruction of the site has been done. Near the middle of the silhouetted image of the monument is a stone with a small nub on top. The stone is the remaining megalith of the central trilithon, and the nub is a tenon — a protrusion that once fitted into a corresponding hole in a lintel stone above.

Bottom: Part of the sarsen circle at Stonehenge. Framed between the two visible sarsen stones is the Heel Stone, 80 meters from the center of the ring. The smaller stones in front of the sarsen stones are two of the so-called Blue Stones, not discussed in the article. Nothing is known about their function, except that they are placed along a circle within the sarsen circle, and that the Stonehengers themselves rearranged them. The stones in the foreground and at the left are fragments; many such stones are present at the site.

This space is left blank so that readers may construct the "Stonehenge Decoder," which is described on the next page.



The Stonehenge Decoder

A cola-can universe, with accompanying sleeve, to show the year-round motion of the sun over Stonehenge.

To construct the device:
Cut out the strip of paper printed on this page and tape it to a twelve-ounce beer or cola can. The can now serves to represent the motion of the sun through the celestial sphere. In particular, that motion can be decomposed into two parts. The first of these, caused by the earth's turning on its axis once each day, is simulated by turning the can on its axis in a clockwise direction. The second, caused by the earth's revolution around the sun each year, moves the sun along the so-called ecliptic, the curved line on the paper strip, one complete cycle each year. To visualize the superposition of these motions, the reader is urged to imagine a roulette wheel spinning in one direction as the sun moves along its track in the other. Now cut out the oval-shaped hole in the insert labelled "Stonehenge Decoder." Position the cola can inside the hole in such a way that the edge of the hole closely meets the wall of the can, and tilts in the direction shown on the decoder. When positioned properly, the uppermost point on the oval's edge will touch the strip of paper along the line marked "north circumpolar boundary," and the lowermost point on the edge will touch it along the line marked "southern horizon." To find the motion of the sun over Stonehenge on any given day, simply choose a point on the ecliptic and follow its motion as the can is turned clockwise, always keeping the can properly tilted relative to the oval. At spring or fall equinox (corresponding to sun-images labelled "March" and "September"), the sun rises due east and sets due west. At summer solstice (sun labelled "June"), the monument reveals its solar alignment: on this day, when the sun is highest over the celestial equator, it rises over the Heel Stone and in alignment with the central axis of Stonehenge, as marked out by the Heel Stone and the central trilithon. At winter solstice, the sun (labelled "December") sets in alignment with the other end of the axis.

If the accompanying drawing and card have been removed, write to the Editors at Room E19-430, M.I.T., for prints of the missing materials.

reason than that the sightlines are considerably longer and more flexible than those proposed by Hawkins for the sarsen ring and trilithons. The early Stonehenge included the previously mentioned embankment, as well as a ring of 56 chalk-filled holes, now named after the antiquarian John Aubrey. At some point in the development of the site there was added onto the ring of Aubrey Holes two mounds and two additional marker stones, known as the station stones (see the figure on page 65). These four features form the corners of a rectangle centered on the sarsen ring, although the sarsen ring had not yet been built at that time. The short sides of the rectangle are parallel to the direction to the Heel Stone; hence they point to the extreme excursion of the sun. The long sides point to the extreme excursion of the moon. (Only at the latitude of Stonehenge are these extremes joined by a right angle; if this is significant, then these relationships were not discovered here, but the observatory was erected at this specific latitude to take advantage of a previous discovery.)

The longer lunar alignments (if so they be) in the early Stonehenge do have sightlines an order of magnitude greater than those from the trilithons to the sarsen ring. Even so, they are short compared to the megalithic sightlines of 18 and 27 miles that Alexander Thom has surveyed at Ballochroy and Kintraw in Scotland. Since Stonehenge seems to be an older site, perhaps the astronomy spread from there to the more accurate observatories elsewhere in Britain.

Indeed, Stonehenge cannot be considered in isolation, for the patient surveying of Alexander Thom and his associates has rather convincingly established the existence of lunar sightlines in conjunction with many of the more elaborate stone circles in the British Isles, a fact about megalithic society now almost commonly accepted by the archaeologists. Yet in Stonehenge III we find no elaborated observing site with longer baselines and more precise markers than the earlier Stonehenge constructions. Instead there is a monumental commemoration in stone of something long since discovered and perhaps already on its way to being forgotten. There is a striking parallel to this in 18th-century India where the ruler Jai Singh created five impressive stone observatories, all completely anachronistic (considering that the telescope had been introduced into India decades earlier), yet comfortable to the monarch's aspirations. Indeed, Jai Singh's instruments remain impressive till this day.

The combination of lunar and solar sightlines embodied in a great ritual center at Stonehenge suggests a well organized primitive cult, possibly with the sun and moon as male and female in some grand fertility rites. Such suggestions are mere speculation, for here the stones are even more silent.

Nevertheless, the idea is no more fragile than the proposition that Stonehenge was a Stone Age eclipse calculator. There is a lunar eclipse cycle of 56, albeit not a very good one, but remember that some of the 56 Aubrey Holes were already covered by the station mounds when the sightlines were getting established. I beg the reader's pardon for not trying here to explain either the cyclic behaviour of eclipses or the imaginative suggestions by Hawkins and by Fred Hoyle for using the Aubrey Holes to calculate eclipses; the references at the end will give a full account.

Suffice it to say that I remain skeptical. There are certain aspects that stagger the imagination. To get the idea that you could predict eclipses in some cyclical fashion, you would have to have some long record of observations and some kind of motivation for recording them in the first place. Such a record would presumably have to be oral. Today we cannot begin to conceive of the significance of oral records. We have too much cluttery detail to remember, and we are not very good at memorizing things. I am sure that memorization must have played a much more significant role for ancient people than it does for us, because we are so dependent on the written record. Even so, such a route to the prediction of eclipses seems incredible to me.

On the other hand, for a people so concerned with capturing the northermost position of the sun and moon, the conception of the moon's nodes (the points at which its path crosses the path of the sun and where consequently eclipses can take place) may not be terribly far behind. In other words, it may well have been possible for the Stonehengers to have correlated eclipses with the celestial geometry of the solar and lunar paths rather than with cycles of eclipses derived from a communal memory of events long past. To me, this seems to be a fabulous jump for neolithic man to have made, but there is nothing to have prevented a Stone Age genius from finding the correlations simply with sticks and stones. So perhaps one of these days we will have to revise our notions concerning the sophistication of megalithic astronomy in the third millennium B.C. Until then, in the words of Aubrey Burl, "This ravaged colossus rests like a cage of sand-scoured ribs on the shores of eternity, its flesh forever lost."

For further reading:

Stonehenge Decoded, Gerald S. Hawkins, Doubleday, New York, 1965.

Megaliths, Myths and Men: An Introduction to Astro-Archaeology, Peter Lancaster Brown, Taplinger, New York, 1976.

Science and Society in Prehistoric Britain, Euan W. MacKie, St. Martin's Press, New York, 1977.

"Stonehenge," Alexander Thom, A. S. Thom, and A. S. Thom, *Journal for the History of Astronomy,* 5, 71-90, 1974.

The Stone Circles of the British Isles, Aubrey Burl, Yale University Press, New Haven, 1976.

On Stonehenge, Fred Hoyle, Freeman, San Francisco, 1977.

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The Gorgon's Eye

Before a myth can refer to the sky, it must refer to the earth. Here are the meanings — earthly and celestial — hidden in the encounter between Perseus and the Gorgon Medusa.

Jerome Y. Lettvin
M.I.T.

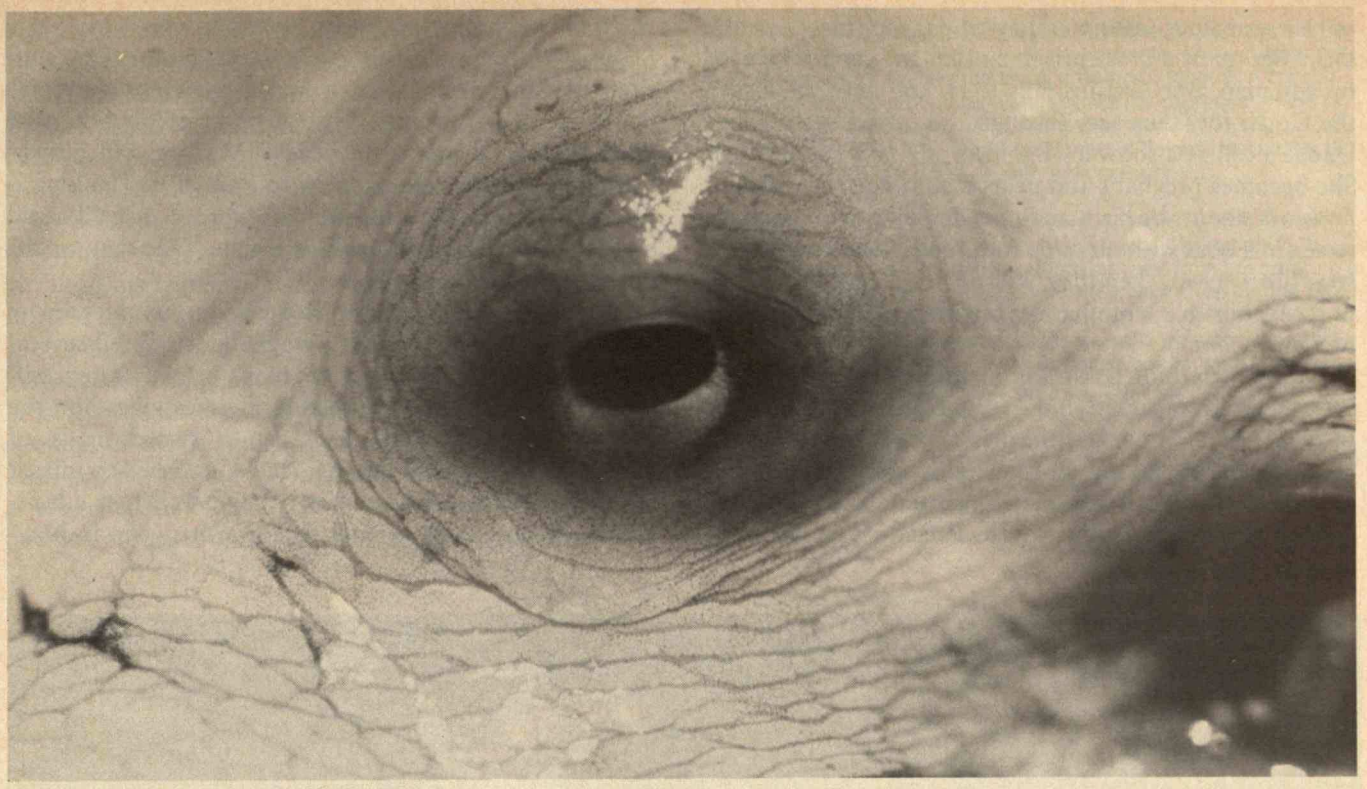
We seldom look at the sky on a starry night. Indeed, some of us will never see it at all, as we pursue our rational goals in the modern world's haze. But in preindustrial times the sky at night was an important matter. There is a lovely passage in *Don Quixote* in which Sancho Panza tells how a shepherd would know what time it was, and thus when dawn was approaching, by observing the position of a particular constellation. If you dip into the works of antiquity all the way back to the dimmest past of any human culture, you will find similar references, similar appreciation of the skies among people at large. It was not a knowledge confined to specialists.

How did the ancients talk about the sky? How did they identify the things that are in it? How did they keep track of those things night after night, year after year?

People who remember orally have no need to remember on paper, so one seldom finds those who are equally skilled at both, because each talent takes a great deal of time. Moreover, one seldom finds written accounts of what it was like to remember in the old-fashioned way prior to the time of writing. One finds only stories that are told and retold. Plato tells of a time when the god Thoth brought the art of writing to Rameses. "What will happen to our memory," Rameses sadly asks, "now that we can keep it on paper?" Thoth gives no answer.

Probably the only written work available to us about the ancient arts of memory is the *Rhetorica ad Arrhenium,* improperly attributed to Cicero. Here we find prescriptions for remembering things. We are instructed, for example, to imagine a walk through a temple, quiet and alone, during which we keep several feet from its wall. The argument that we wish to remember becomes associated with a sequence of things we see on the walk within the temple; and indeed the English word "topic" derives from *topos,* or place — a topic is the place in the temple to which we have attached an idea in the course of our walk. In effect, the temple comes to embody a kind of cross-mapping, in which something that we wished to remember superimposes itself upon something that we already knew very well. The temple is thus a stable and well-known ground on which the new set of facts is arrayed: the temple serves the purpose of a theory, to the extent that you can derive from a theory a great many facts, that, though seemingly unconnected, can nevertheless be related by the mapping you have made.

We have, therefore, an art of memory in which a well-known universe can serve as a ground upon which other universes can be mapped. But when you do such a thing, the world is no longer held together by what you might call conventional reason or logic. This leads to a curious kind of frustration when you seek to investigate the past. Consider, for example, that if you examine the Egyptian temples of Ra, or the temple supposedly devoted to the star Sirius, you will find that they are oriented upon very specific points on the horizon: the point of solstitial rising in the case of the sun, and the point of heliacal rising in the case of Sirius. (Other articles in this issue explain these matters.) Now given these temples, all oriented in special ways and all dedicated explicitly to the god of the sun or



The eye of the common octopus, *Octopus vulgaris.* It is an organ much like the eye of man, for both structures have a cornea, an iris, a fluid-filled chamber, a lens set in a ring muscle, and a tough, fibrous sheath surrounding the eyeball. Moreover, both creatures have eyelids. Such similarities are most astonishing, considering that nature seems to have engendered the eyes of men and octopuses by entirely distinct lines of evolution.

the star, one cannot easily argue that the alignments were accidental. And once you admit that the Egyptians made astronomical devices, you must also admit that the Egyptians had a prior knowledge of astronomy, even though that knowledge may not be translatable into the explicit terms that we ourselves employ. The problem is that the scholars who have studied the various temples find chiseled or painted on their walls what appear to be fairly unsophisticated stories: Ra did this, Ra did that, Ra returned. In short, the Egyptians inscribed picaresque stories on the cases of first-class scientific instruments, and this seems wrong-headed. It is as if one had unpacked an oscilloscope, looked in the box for an instruction manual, and found instead a book by Dr. Seuss.

Still, let us assume that the ancients spoke in parable, namely that what was said was put in rhetorical terms because of not having a language with the modern exactness — not having, that is, the terms in which to express even simple trigonometric relations, such as the position of the sun along the horizon on the day of summer solstice. And let me invent a fantastic astronomy so as not to scandalize the astronomers. Suppose I were to say that Floog suckled Goom. You would immediately have a feeling that the one preceded the other in time: that Goom was born from Floog, and therefore came later. This is a nice way to communicate the notion of a close time precedence, say, of a star appearing with respect to the sun at a place like the horizon. For you no longer have to remember an abstract relation about lights in the sky. You remember instead a concrete relation which is rich enough to include among its interpretations the particular one that you mean to emphasize.

I say, accordingly, that the myths of the ancients embody the relations among the stars spoken of by ancient astronomers. I say also that the myths may mean many other things besides. Myths, after all, are synthetic propositions, made in this world and subject to all the ambiguities and interpretations of any comment that isn't couched antiseptically in the precise language of modern science. But that only adds to the richness and, if you wish, the memorability of the ideas. For myths are more memorable the more things one can map on them. And there is for me a great poetic quality in a language whereby the relations of animals to each other, people to each other, the heavens to the earth, the gods to humankind, can all be worded in about the same way, until finally, by a single set of sentences, I can remember all of the universes as if they were maps of one another.

Before one can invent a myth about the skies, however, one must invent a myth about the earth. For the ancients had no way to speak of relations among mere points of light. Therefore, let us begin with something terrestrial, upon which the stars will later be mapped. Since the Greek myth of Perseus is considered to be rich in astronomical associations (about which more later), I will attribute to it a terrestrial significance.

Here is the myth itself. Perseus is born under strange circumstances: Acrisius, King of Argos, has been told by an oracle that he will be killed by his grandson. He has

only a gorgeous daughter named Danae. He therefore locks her up in a brass prison so that she cannot be eyed by any man. But Acrisius fails to reckon with the lust of the Gods, for Zeus sees through the prison wall, enters Danae's cell as a shower of golden rain, and seduces her. She becomes pregnant and bears a son: Perseus. Acrisius finds out about the birth and puts daughter and grandson to sea in a boat without oars. If the gods want to save Perseus (he argues), then *they* will do so; if not, *they'll* kill him. Acrisius has nothing to do with it — a marvelously modern position.

The boat is blown ashore on the island of Seriphus, where Perseus is put up in the temple of Pallas Athena, to be educated and raised by the priests. As Perseus grows to teen-age, the local king, Polydectes by name, conceives a passion for Danae. But he makes no attempt at seduction, fearing reprisal from the youth. Perseus is in his teens when the king throws a party. Everyone who is invited is required to bring a gift horse. Perseus, who has no patrimony with which to get a horse, comes to the party nonetheless, and promises instead to give Polydectes the atom bomb of the time, the head of Medusa, which turns to stone anybody who happens to look at it. The king is pleased: either he'll get the ultimate weapon or he'll be rid of Perseus and have his will of Danae. One way or the other, he benefits greatly.

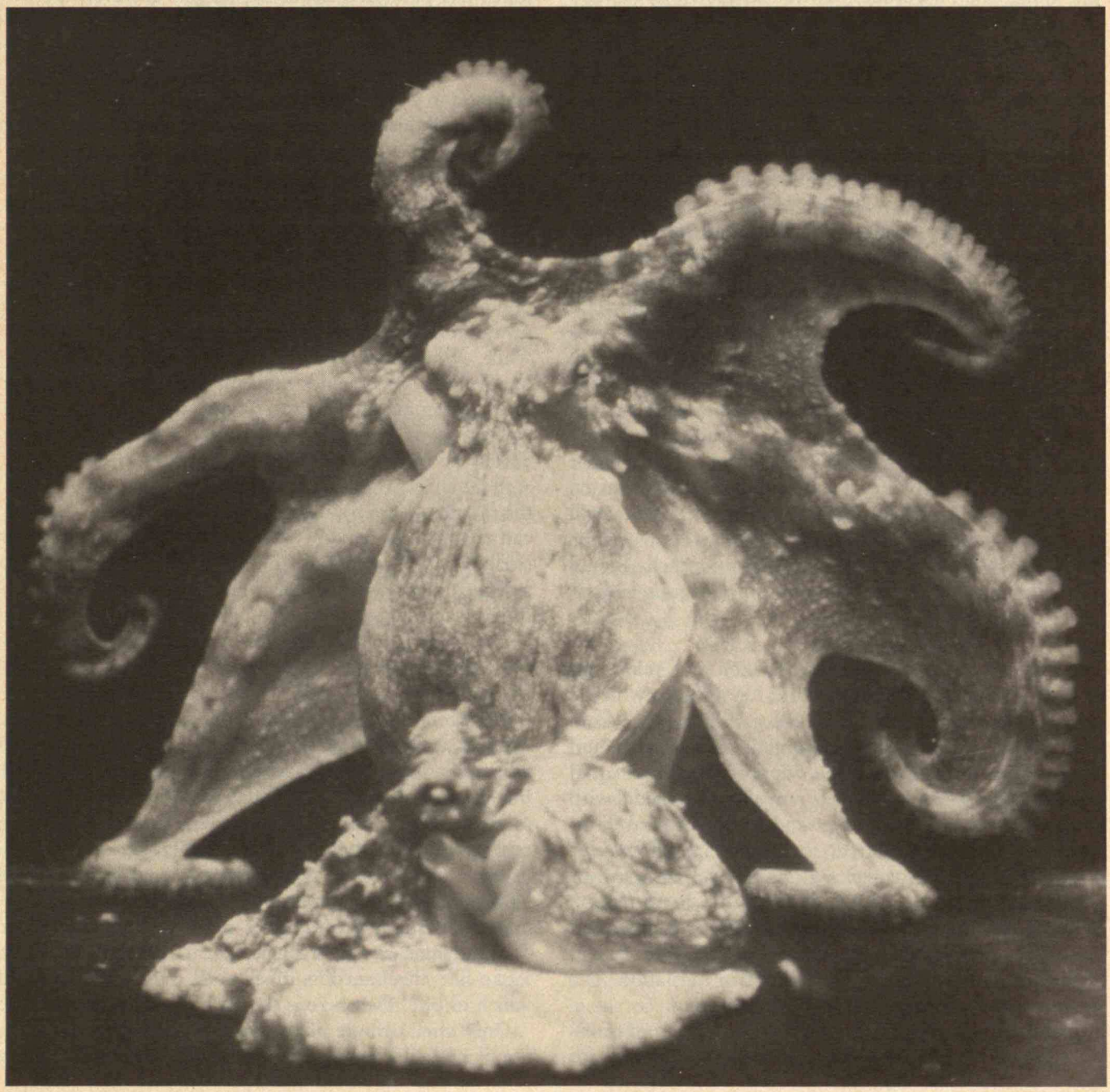
Perseus now sets out after Medusa. But first he goes by night to the temple of Pallas, where he is offered several gifts from the gods. Hades gives him a helmet of invisibility: it renders the wearer unseen. Hermes gives him the famous winged sandals and also a sword made of diamonds. Pallas gives him her shield, polished to mirror brightness. Perseus also receives a magic wallet, or kibisis, which can completely engulf whatever is put in it, how-

ever large, and yet not itself increase in size.

Provided with these devices, Perseus takes off in search of the three Gorgon sisters, of whom one is the Medusa. To find them, however, he must first inquire of the Phorcyades, three sisters of the Gorgons, who know where the Gorgons hide. The Phorcyades are like the landladies of Beacon Street: they have only one eye and one tooth that they pass back and forth among themselves. Invisible by virtue of his helmet, Perseus swoops down, snatches the eye and tooth, and promises to give them back only if the sisters will tell him where the Gorgons lie. This they do. Perseus returns the parts and takes off again. From a vast height, he sees the Gorgons, sunning themselves and sleeping at the seashore in Kisthene, the land of rock-roses. Of the three, Medusa alone is mortal. Gazing only at her reflection in the mirror shield, Perseus comes down backward, lops off her head, and thrusts it into the wallet.

Left: The head of a Gorgon, a creature whose gaze turns men to stone. The head is ringed by writhing serpents, and out from the grinning mouth protrudes the awful creature's tongue. A tongue protruding in that curious fashion is typical of representations of Gorgons from antiquity. The drawing was made by Ruth McCambridge from an original fashioned in painted terracotta by Etruscans of the late sixth or early fifth century B.C.

Right: The common octopus (*Octopus vulgaris*), which lives in warm waters around the world but is especially common in the Mediterranean Sea. Eight arms radiate outward from the creature's head. They are joined at their bases by a filmy web. On the head itself, two eyes can easily be seen. Just to the side of those eyes, the creature's siphon appears; it is a tube with the maneuverability of a tongue. The large, pouch-like structure beneath the eyes is the so-called mantle. The octopus thus far described is a female; the photograph also shows a male, lying at the bottom of the tank with one of its arms — the so-called copulating arm — in the process of fertilizing the female. The male's siphon is quite plainly visible. This photograph (and the one on page 75) was provided by Professor Jerome Wodinsky of Brandeis University.



The remaining sisters wake up and cry. (Inspired by these sounds, Pallas will invent the flute.) From the neck of Medusa's body issues a storm cloud whence come her two children: Chrysaor, the Golden Sword; and Pegasus, the Winged Horse. Perseus escapes by means of his magic helmet and sandals. He goes through a variety of adventures, using the head to turn kings into rock piles, rescuing and marrying Andromeda, and finally killing off his grandfather as was predicted. It's a beautiful story.

But what I wish to examine most closely are the Gorgons and Phorcyades. Who are all these sisters? Monsters from the id, from within the human unconscious, as if the ancient poets were H.P. Lovecraft or Carl Jung writing in a previous incarnation? (I have long felt that H.P. Lovecraft is Jung's nom de plume in English: both are devoted to calling up vague, subliminal feelings about things that are never described or expressed.) There is a remarkable amount of structure about the pair of awful triplets. For one thing, the Phorcyades, as well as the Gorgons, and indeed most of the other monsters that inhabit the Mediterranean, are spawned by Phorcys out of Ceto, Phorcys being the ancient god of the sea and Ceto his sister. Of the Phorcyades, nothing too much is said; they are the gray ladies. But about the Gorgons the poets are explicit. Now the poets were emphatically not advertising copywriters; they were people to whom words apparently meant something. For despite the fact that there were administrators at the time, language had not yet been overly corrupted. The Gorgons, say the poets, can turn from black to white and back again in an instant. They have living snakes for hair. Their gaze turns living creatures to stone. And they have "beautiful cheeks" — a curious phrase for beings so terrible. One further attribute: on one of the Greek Islands, there is a temple to the goddess Gorgo, a temple with the same form as that which the Parthenon was later given. And on the pediment of this temple is a tremendous Gorgon. Its tongue is sticking out. So also does it stick out for the Gorgons on medallions, vases, reliefs. The modern Greek scholars will assure you that this was a sign of fear or terror among the Greeks. But that is a strange sort of assertion; why should a tongue sticking out appear only on Gorgons and no other creatures?

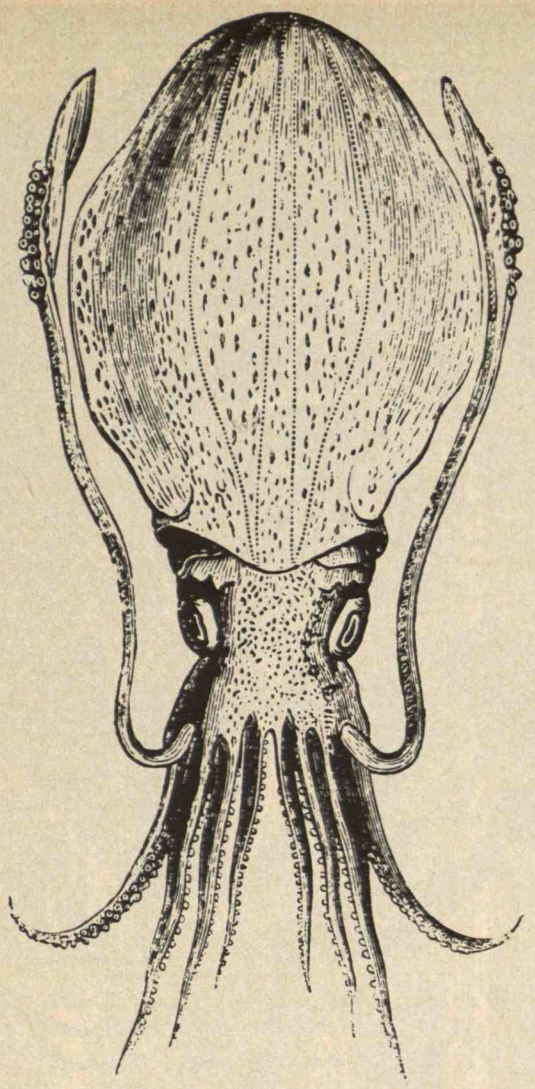
Does any of this make sense other than as a tale to be marketed at an occultist bookstore? Let us begin with the gifts that Perseus received from the gods and move from them to the properties of the Gorgons themselves. Squid are common in the Aegean Sea. Suppose you take a squid and cut off its head. Its shape is now that of a sandal with wings at the toes — the flying sandal of Hermes. And indeed, as Aristotle reported, the squid are known for flying: if a school of squid is attacked by a large fish or otherwise frightened, all of them shuttle in formation forward a short distance, and then, with a sudden and powerful contraction, force a strong jet of water out of their funnels to shoot into the air, still in formation. The entire school can travel thirty feet at a jump.

Consider now the helmet of invisibility — not of transparency, for the Greeks had a perfectly good word for that. A famous statue of Athena includes a helmet in the shape of a (headless) sepia — a cuttlefish. They, too, are common in the Aegean Sea. And what is interesting about the sepia is that it vanishes against every one of its surroundings; it is the most difficult animal to see under water, because it can change its color — and the pattern of its colorations — to suit any surrounding.

Then we have the wallet that never grows larger, no matter how large its contents. Anyone who has ever watched an octopus feed will know of a resemblance here. I myself have given an octopus 35 crabs — an aggregate much greater in size than the octopus itself. Yet every one of them vanishes into the depths of the creature, and the octopus never grows larger. That is because the octopus first hides them all in the spaces under the interbrachial web between its outspread arms. This space is much greater in volume than the mantle (the body) of the octopus. The crabs lie immobile, for the saliva of the octopus has paralyzed them. Even then, however, the octopus does not precisely eat its prey. The saliva liquefies their flesh, and the octopus then sips them, as we sip coffee. The octopus, like the other creatures I have named, is common in the Aegean Sea.

I offer all this as prelude. The next step is to account for the poets' description of the Gorgons. Accordingly, I ask: what animals turn white to black and black to white in an instant? All the cephalopods I have just described: the squid, the sepia, and the octopus. What animals have snakes for hair? Consider the octopus with arms spread out above its staring, bulging eyes. And consider that if one of the arms is severed from the body, it will wiggle away on its own and stay alive and irritable for quite a while. What animals have beautiful cheeks? Put your hand under water, and you will find that the octopus blows water at you. Whatever blows can, with reason, be called a set of cheeks, especially since in the octopus these cheeks lie below the eyes, as the snaky locks lie above. And the cheeks of the octopus — which we less vividly call the mantle — are beautiful because they are colored and can change their colors. What about a Gorgon's tongue sticking out? Protruding from beneath the octopus is its so-called siphon, which has much the same mobility as the human tongue and can be pointed in any direction. It is always hanging out, and this is not a sign of fear; it is the hallmark of the cephalopods. What about the exchange of eye and tooth, which Aeschylus attributes to the Gorgons as well as to the Phorcyades? The eyes of an octopus are backed up by a large blood sac or sinus, and when two male octopuses meet side by side, the eye of the first protrudes as the sinus inflates, so that the eye seems to grow to four times its normal size. The eye of the second responds in kind, and finally the weaker one retracts its eye and goes away. As for the exchange of a tooth, a fight between two octopuses will suggest an analogy. For first one octopus protrudes its beak and then the other does the same, as they struggle in arm to arm combat that looks like the Laocoön. If a tooth is a structure with which to bite, then here is the exchange of a tooth.

Only one attribute of the Gorgon Medusa remains — the most well-known and horrific attribute of all. What



The common European cuttle-fish or sepia, *Sepia officinalis.* The creature, like its fellow cephalopods the octopus and the squid, boasts chromatophore organs over the entire expanse of its skin. The organs include pigmented discs, white, red, yellow, or black in color; and under the control of the nervous system, these colored regions can be revealed or hidden. The result is that the creature can abruptly change color, taking on a uniform, a mottled, or even a striped appearance so as to vanish against its background. The shape of the sepia, when the head and tentacles have been excised, is much like that of a helmet often depicted in Greek statuary.

animal has a gaze that turns other creatures to stone? Drop a living crab into a tank occupied by an octopus. The crab begins to scuttle about, the octopus opens its eye — and the crab stops in mid-flight! For if the crab moves even the slightest fraction of an inch the octopus will grab it. Its only way of hiding is to be motionless — and nature has arranged for it not to move.

Surely the Greek fishermen knew of the lives and habits of the squid, the sepia, the octopus. Here then is a story in which no fact is left dangling. Here are the daughters of Phorcys the seagod. Here are the three sisters; Aristotle called them all molluscs, and he was right: the cephalopods are the sapient cousins of the clams. Squid, sepia, and octopus are the only cephalopods on the shore of the Aegean Sea. They are memorable because when you look at them, you cannot help but remember their story. And when you remember them, you will find that you are walking quietly and alone in a frame of mind like a true temple. Along the wall of properties is a series of topics, a set of events or attributes which you can now ascribe to objects in the sky. You are edified, for no set of relations in the sky alone was sufficient to determine a theory, to build a thought temple, with the only language available to you.

Let us suppose that the Medusa, whatever meanings she may later have assumed, just possibly began with the description of an octopus. Does this help us at all in dealing with the astronomical counterpart of the myth — the constellation named Perseus? To be candid, I don't at first see that it does. Indeed, the more I regard the starry image, the stranger it becomes in this sense: there is no geometry that seems to hold between the stars of the constellation, and nothing about the position they enjoy in the heavens, so that the name Perseus should necessarily have been conferred upon them. Is the whole of the myth so abstract a mnemonic that any set of stars might have done as well?

I am going to suggest an answer that will seem brash to historians of astronomy, because the proofs lie in the absence of a piece of evidence — as with one of Chesterton's detective stories. But first consider the astronomy.

A little below the midpoint between the sword brandished by Perseus and the heel of his right foot in the figure on page 80 lies a quartet of stars, the Gorgoneae, or the Gorgon's Head (*Caput Medusae*) in Ptolemy's catalogue. Even Perseus himself is not so fixidly named as is this Head. For all the sundry versions of the constellation, from the Cacodaemon of the astrologers to the al Ghul (The Bearer of the Demon's Head) referred to by the Persian Hamil Ra — all of these reflect a malignity at the constellation's center.

The brightest star in the Caput Medusae is called al Ghul. It appears as the right eye of the Medusa on page 80, and concentrates the malignity of the Demon's Head to a single light whose usual magnitude is 2.3. Algol is also called Gorgonea Prima, but it is known to modern astronomers as β Persei, the second most luminous of all the stars in Perseus. Sometimes it looks red.

The next brightest star of the Medusa group is ρ Persei, or Gorgonea Tertia, whose maximum amplitude is 3.4. It is orange in color. The two dimmest stars, π Persei, or Gorgonea Secunda, of magnitude 4.5, and ω Persei, or Gorgonea Quarta, of magnitude 5, complete this segment of the constellation.

Now Algol, which is called Tseih She, the Piled-up Corpses, by the Chinese, is called Rosh ha Satan (Satan's Head) and also Lilith by the Hebrews. There seems to be a general consensus in its naming — a consensus which is shared by the astrologers, who consider it the most dangerous star in the heavens: a carrier of misfortune, a mediator of violence. Probably its most revealing name is that of the Blinking Demon, but we ought not to count that title since Allen, writing in his popular book *Star*

Perseus holds the severed head of the Gorgon Medusa in a representation of the constellation Perseus taken from the *Firmamentum Sobrescianum,* a sky atlas published by Jan Hevelius in 1687. In this depiction, the hero who killed Medusa wears the winged slippers of Hermes, which enable him to fly; he wears, too, a helmet which renders him unseen; and he wields a sword made of diamonds. A quartet of stars defines the face of the Gorgon: in this version, ρ Persei is at the tip of the nose; ω Persei is to the right of the nose; π Persei is the left eye; and β Persei, or Algol, is the right eye. The constellation, incidentally, is reversed left to right from the way you would see it if you looked at the sky. The reason is that some atlas-makers used a celestial globe in the

preparation of their drawings. Helvelius, for one, did so. Accordingly, any given portion of the sky appears in his atlas as if it were inscribed upon the surface of a sphere and the observer were outside, looking downward upon it. As we actually look at the sky, however, it is as if we were *within* a sphere, and gazing upward.

Names and Their Meanings, finds no evidence that it was known as such in antiquity.

Still, Algol is unique among all the stars in the sky in that it literally "blinks" in the course of a single night. This phenomenon was observed scientifically in the late seventeenth century, first by Montanari and then by Maraldi. But the most interesting communication about it, reporting the existence of minima and maxima in the brightness and an overall periodicity of two days and 21 hours, was done by a deaf and dumb 18-year-old boy and read at the Royal Society in 1782. The boy, John Goodricke, Jr., of York, died four years later, two weeks after being admitted to fellowship in the Society. By then he had discovered the variability of the stars β Lyrae and δ Cephei. He had also correctly guessed the source of Algol's variation, although Herschel never accepted the explanation.

Algol is an eclipsing binary star: a bright star with a dull companion that periodically gets in its way as seen from earth. For two and a half days, it remains more or less constant at 2.3 magnitude. But then, over about three and a half hours, it drops — first slowly, and then rapidly — to a magnitude of 3.5. It stays at this dimmer value for about two hours and then recovers to its fullest brightness over the next three and one-half hours. Of all the variable stars in the sky, Algol is not only among the brightest but is also that which uniquely shows the steepest variation. Its time course of change is given on page 83. Gorgonea Tertia is also a variable star, changing from 3.4 to 4.2 in magnitude, but not over so rapid a course.

One last astronomical fact must be mentioned here: the divergent point for the Perseids — the meteors of summer — lies at the wrist of Perseus. In other words, the wrist is the point from which all the meteor paths seem to issue; and this makes direct sense of a piece from the myth. Hermes, you will remember, gave Perseus a diamond sword. Why diamond? It was not then a cutting tool as it is now in electron microscopy. And I refuse to believe that significant words are tossed into a myth for the sake of mystification. The shower of Perseids in late July and early August occurs as if issuing from the wrist of Perseus the constellation, and I can imagine no more apt metaphor for that fan of falling stars than a sword of diamonds cleaving across the sky. But a strong feeling plus a coincidence do not constitute a proof, so I will only suggest that the myth is to be taken in this way.

Far more important is the Caput Medusae. To understand it properly, we are led to a mythic theme of great power and antiquity — the story of the Evil Eye. The best and most delightful account in English is Elworthy's book, supplemented in part by Gifford's later work, which relies heavily upon it.

The legend of the evil eye is as ancient as scribed artifacts. It existed already among the Sumerians and is well developed in the oldest records from Egypt. One finds it in China, India, the pre-Columbian cultures of the Americas, among the Eskimos, the natives of the Kalahari, the inhabitants of New Guinea, the Polynese — in short, everywhere. It is the eye whose glance brings

evil. To be "fascinated" is to be ensorcelled by this eye.

Among the most amusing modern examples of the evil eye is the case of that amiable 19th-century pope, Pio Nono, whose malocchio was so notorious that workmen refused to renovate the Vatican unless the pope were guaranteed to be elsewhere. The quintessential evil eye, however, belongs to mythic characters. One of my favorites is the Irish hero, Balor, whose eyelids were swollen up in his youth by accidental contact with fumes from a witch's cauldron. Balor became the major arsenal in his nation's army. He would be positioned to face the oncoming enemy, and four assistants with fishhooks would raise the swollen lid until his baleful gaze was exposed to annihilate the attackers. He came to a bad end, though, for it took so long to lift his lid that an enterprising rock-thrower hit his eye before it was exposed and knocked it through the back of his head, whereupon its gaze desolated his own army.

Minor legends of this sort are the joy of story-tellers everywhere. But the major myths of the evil eye are always terrifying. They include the accounts of Lilith, the Medusa, the Strix, the Onocentaur, the Lamia, the Empusa, to mention but a few in the occidental tradition. Various animals also have the power of fascination — the serpent, the owl (who is the bird of Pallas), the cockatrix, the basilisk or salamander, the locust and the grasshopper, and so on. It is hardly surprising that from such a tradition the perceiving eye emerges as an emissive rather than a receptive organ.

The mythic figures from antiquity that are mentioned above share several common features: they are all feminine, they all have removable or alterable eyes, and they are all malignant. One might have imagined that things should have been otherwise — or at least that certain male figures, notably Argus and the Cyclops, should have shared the females' traits, for their mythic significance also rests on their eyes. Yet those latter orbs are neither powerful nor evil. Nor is the eye of Zeus himself, though he sees through the walls of Danae's prison. It seems that the comparative mythologists speak with reason when they talk of the Eye-Goddesses — including Ishtar and a whole host of figures from India and the orient generally. Although the concept is far from clear, and certainly far from general acceptance, the motif of all these goddesses is the powerful eye.

Consider Lilith. According to a Talmudic account, she was Adam's first wife and a daemon, but not necessarily malign at first. She was a night spirit, and bore Adam's children before Eve was brought forth from Adam's rib. Then, however, she was abandoned for Eve, whereupon she destroyed her own children and went forth as one of the midnight hags to prey on the children of others. She fascinated; and she could remove her eye and hide it. To her is attributed both beauty and a terrifying appearance, quite like that of the Medusa. In a later period she merges with the Lamia who preys on young men as well as children. The newborn, in particular, had to be protected from such deadly ones.

It is interesting, in this respect, to note that the newborn infant in Greek villages, even at this century, is protected specifically from starlight for at least eight days and up to a month and a half, for otherwise the stars might "overlook," i.e. fascinate the child.

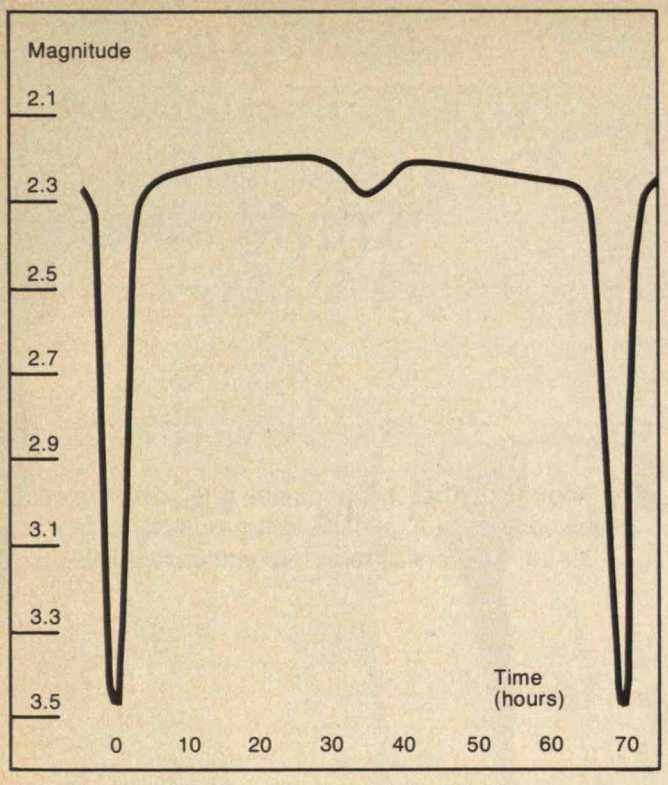
Now language is always a great trap in all texts, sayings, and doctrines that come down from the past. This is doubly the case when one deals with the oral tradition, in which nothing is written down. It is therefore of only passing interest that one of the bucolic English phrases for being affected by the evil eye is "to be blinked over," and that the English name for Algol is "the blinking demon." I must lay ground far more carefully.

The thesis that I mean to advance is that Algol and quite possibly Gorgonea Tertia (ρ Persei) were the eyes of the Gorgon, of Lilith, of the Lamia, of the creatures whose glance was deadly. These stars became the evil eye in the sky particularly by virtue of their blinking; and they were thus the nucleus around which the constellation Perseus was erected. I mean also to suggest that the constellation Perseus is one of the longest in the sky because the "diamond sword" had to be accommodated since it, too, was associated with the death of infants. And, finally, we know these features, I propose, precisely because there is no direct evidence for them.

Let me pursue, first, some non-astronomical matters. Algol, as I remarked, blinks quite visibly in the course of some nights. One does not need a telescope or any other instrument to tell that it varies, for it changes almost a whole magnitude in but three hours, and given the stars around it for comparison (especially Persei ρ and π), the change is eminently noticeable to watchers such as young Goodricke. Accordingly, given that the star-watching of antiquity was not always directed at the horizon, for the zodiac and the constellations had to be defined, and given the appreciation of secular process that identified the planets — the wanderers — and even the slow precession of the skies from year to year, is it reasonable to suppose that a bright, blinking star could escape notice? One might argue that all the stars were eyes in the skies, yet this, I suspect, is a great folly. What characterizes the eye of all land animals as well as the Medusa herself is the veiling and unveiling, the opening and shutting. It would be a surprising coincidence that Algol defines the head of the Medusa had the blink not been noticed.

But then why is Algol never *said* to be the eye? Heaven knows that the astronomers and astrologers are specific enough about forearms, elbows, knees, and a variety of other parts. Indeed, the various parts of Perseus himself are identified, and furthermore, the four Gorgoneae are plainly held to be a head, the Caput Medusae, by Hipparchus and Ptolemy. It is thus a bothersome omission that the most dangerous star in the sky is not identified except by indirection — or rather, it is bothersome until one recollects, with some poignancy, the nature of naming.

After all, it is not obscure or newly found knowledge or a mere invention to point out that if one named a demon or a malign influence, one attracted its attention. Remember how the Eumenides (the Furies of classical mythology) were never named as such, but called instead the Gracious Ones. Remember the proscriptions directed



A light-curve for the star Algol. The vertical axis shows the apparent luminosity of the star; the horizontal axis shows time. Plainly, then, the star's brightness varies: it drops 1.2 magnitudes and then returns to its maximum value in a matter of hours. This dimming and brightening of Algol — this blinking, so to speak — occurs once every two days and twenty-one hours.

by the Jews against the utterance in any way of the true name of God. From Ra to Rumpelstiltskin, the names, if uttered, generate a direct connection of the power to the self. And this precept, strong enough in religious matters, becomes of even greater consequence in daily beliefs, or superstitions. In the hands of the elite, naming gave a touchy power over demons. And in the mouths of the other classes, naming was fatal. This is a basic social rule.

Here, then, is a demon's head among the stars, its eyes blinking down on the world. Who is intrepid enough to call forth the "overlooking" (the supervision, the episcopacy) of that eye upon himself by naming it, describing it, examining it carefully to determine the rapidity of blinks — in other words, by doing everything possible to call its attention?

Now let me add a trivium. What do falling stars signify? Does it really surprise anyone to know that across many cultures each meteor corresponds to a sinless soul entering heaven, to a new-born child dying, to the death of a saintly one — always to death? But this shower of Perseids is, I claim, the diamond sword wielded by the hero who carries the Gorgon's head whose blinking eyes covet the souls of the newborn — the Lilith, the dread Lamia, the caeodaemon.

We are told from ancient times that the sea and the sky are mirrors of one another. We see now that the mirror is not meant in a trivial sense; it is a mirror of relations. That is to say, what characterizes one can be read into the other, and without such a reading there is no language for expressing an astronomy in the first place.

This must be true even for physical reasons. Suppose you were to maintain that the ancients meant a literal mirroring of the sky in the sea, pointing out the lovely symmetry of the moon and its reflection on a calm night. But have you ever seen the stars reflected, save perhaps Sirius? For water, as glassily quiet as in a windless lagoon, drops what it reflects by four magnitudes, as Minnaert remarks. Thus we can guess why Perseus comes to the Medusa with reflecting shield — for what you can't see in a mirror can't see you in that mirror. Think, if you will, of stars reflected on a polished brass shield and tell me — given the specular and diffuse reflectances of brass, can you see Algol or, indeed, the eye of anyone behind you? I think it possible that there never existed, during the eras in which the Perseus myth formed, a mirror capable of showing the stars, and that is the meaning of our hero's shield. (Narcissus fascinated himself in daylight and on still waters in a glade because it is just possible to make out your own eye against the bright background of the sky light, even filtered and reflected through the trees.)

It seems to me that the study of archeoastronomy now proceeds along two lines. On the one hand is the thoroughly admirable strategy of looking at ancient artifacts and deciding what they signified. On the other hand is the thoroughly dangerous strategy of exploring the poetical language of myth. It is dangerous, for if all you can see in the myth is the human unconscious — if all you can see is yourself — then you have embarked on a second-rate venture. But if you can see the stars in a myth, that is far better. For you don't know the stars as well as you think you know yourself.

It is dangerous, too, because you are sure to go too far when you attempt to reinterpret myth. I myself have gone much too far in this article, and so can be accused of making my own myth to render memorable the sundry places in the sky. I am not offended by that charge at all. If you find the story of the octopus, Algol, and the Gorgon Medusa irritating enough to recall, I will have explained the ancient arts of memory more by illustration than by proof. Most of you, of course, may prefer a rational account of things; but I was never one to put Descartes before Horus.

For further reading:

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The Nature of Light and Colour in the Open Air, M. Minnaert, Dover Publications, New York, 1954.

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The Language of Archaic Astronomy: A Clue to the Atlantis Myth?

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M.I.T.

Scholars have long searched the earth for evidence of the lost civilization called Atlantis. It seems, however, that Plato's story may not refer to the earth at all.

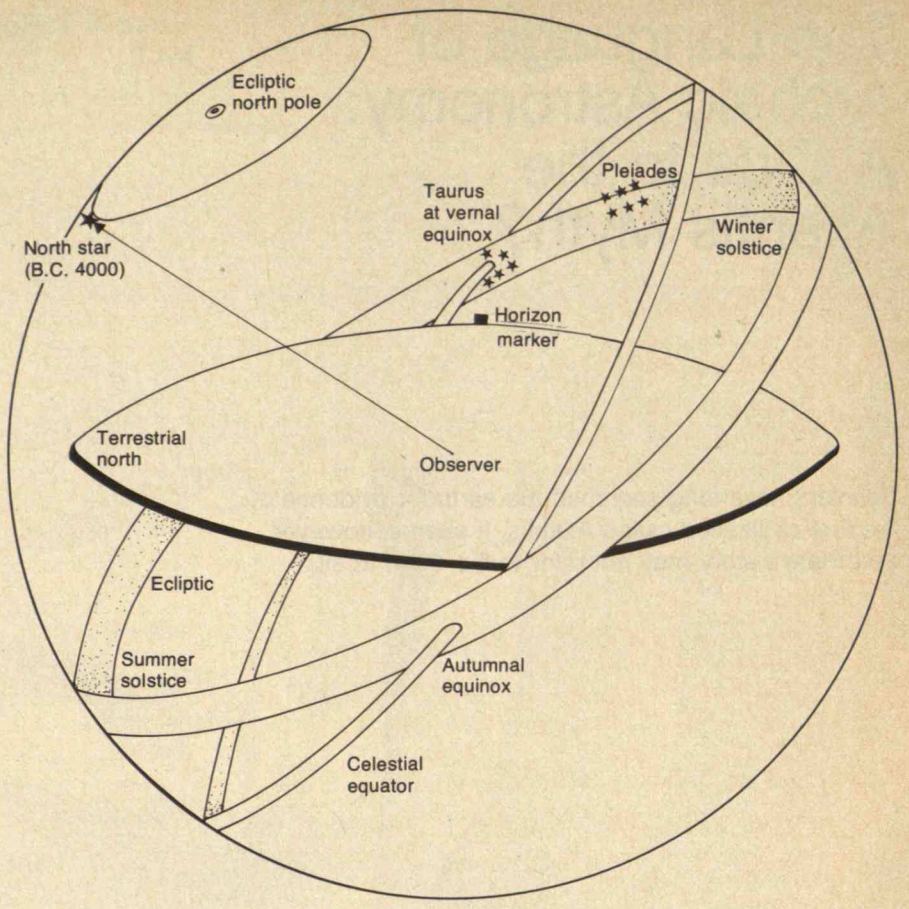
It is clear that Stone Age man lacked our coordinate systems, our spherical geometry, and our computational techniques. Indeed, it is clear that he lacked writing itself. It is equally clear, however, that the administrators in charge of Stonehenge and similar structures succeeded at the following exacting tasks: they justified to a larger lay public the great communal effort required for the construction of the facilities; they explained to their assistants the rationale and the procedures for working with the numbers and celestial alignments embodied within; and they insured, again without writing or mathematical notation, the accurate transmission of these procedures from generation to generation across the centuries. How did they do it? What did they use for the requisite technical language?

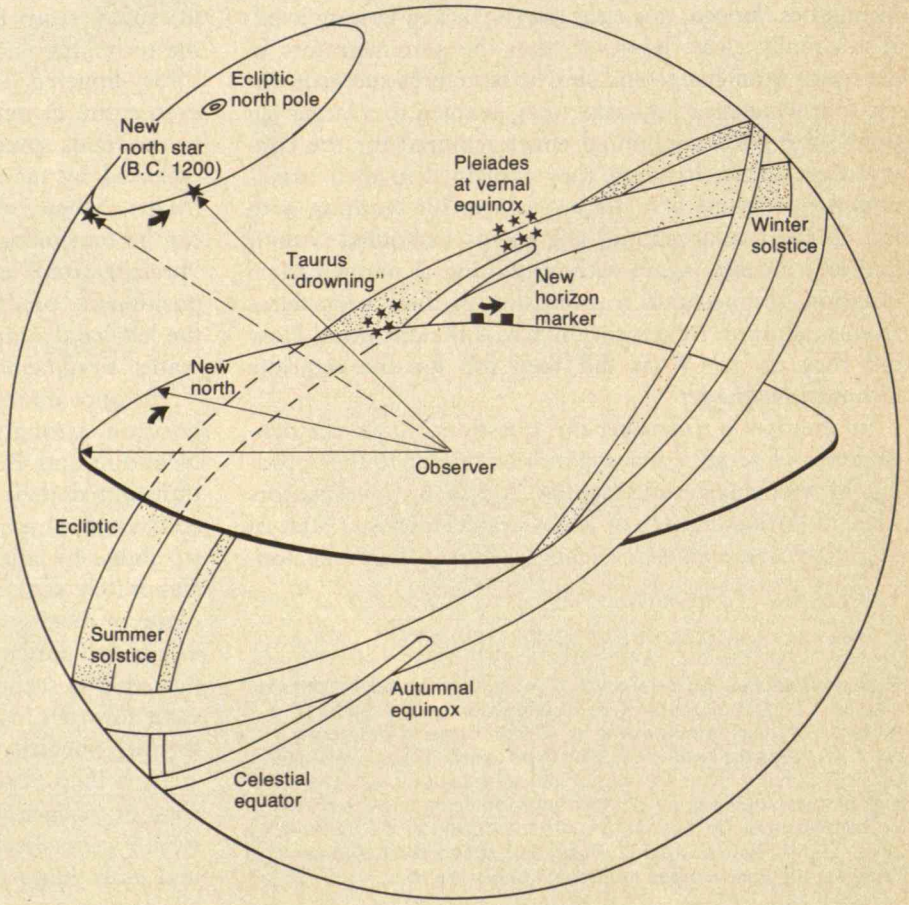
In attempting to answer this question, we are the beneficiaries of a line of investigation unrelated to the decoding of Stonehenge and similar efforts by investigators such as Alexander Thom and Gerald Hawkins. First of all, in the late nineteen-twenties, Milman Parry demonstrated at work in the language and structure of the Homeric epic a technique of composition still discernible in contemporary Serbo-Croation oral poetry. The crux of the technique is a vast storehouse of formulaic phrases ("rosy-fingered dawn," "swiftfooted Achilles" . . .) and even entire formulaic lines ("But they raised their hands to the foods spread out before them.") collected and recollected by many generations of practicing bards. By means of them, whole sequences of events in epic recitals can be remembered, for the phrases and lines are fixed, "prefabricated" elements, at once metrically correct and positionally predictable. In much the same fashion does the left hand's familiar combinations of chords enable a pianist to remember a given melodic line.

The appearance of formulaic devices in Homeric composition strongly suggests that the form in which Neolithic and Bronze Age astronomers explained and transmitted their knowledge was rhythmic (i.e. metric and versified) speech, perhaps coupled with melody and (to judge by analogy with Far Eastern temple dances) elaborately stylized pantomime. After all, a useful technique of memorization is unlikely to have remained undiscovered until quite recently. It has even been suggested, plausibly it seems, that Agamemnon may have cast in verse form his instructions to the fleet assembled at Aulis for the expedition against Troy.

Then there is the work of Hertha von Dechend, historian of science at Frankfurt University. For the past twenty years Professor von Dechend has been comparing and assembling the pieces of an immense puzzle com-

Poseidon reaches downward with a set of luminiferous calipers to map out concentric bands of earth and water on the island of Atlantis. The illustration, made by William Blake in watercolor, black ink, and gold paint, has come to be called "God Creating the Universe," but it might with equal justice be taken to represent the mythological theme of an Engineering God designing the cosmos. In Greek mythology, Kronos creates the design of the universe at large; and in Plato's writings, Poseidon, acting in his role as Engineering God, creates the design of his island.





The slow eastward slippage of the zodiacal constellations, together with our modern understanding of what causes the phenomenon. The celestial sphere at the top shows in schematic form the relations that obtained in B.C. 4000; the angles are those applying for an observer at the latitude of Babylon — about 32.5 degrees North. On the day of vernal equinox, the observer establishes a marker at the horizon to show the place where the sun rises. As the stars disappear in the morning light, he observes that the sun occupies the house of the constellation Taurus. The illustration also shows the Pleiades, higher in the sky. The celestial sphere at the bottom shows, again schematically, the alignments that obtain for a Babylonian observer 2,800 years later, in B.C. 1200. On the day of vernal equinox, he finds that the sun occupies the Pleiades, and that he must move the ancient horizon marker to the west in order to accomodate this fact. Taurus, meanwhile, has sunk in the sky on an eastward slant, and is only partially visible at the horizon; the observer of 1200 B.C. might say that it is "drowning," and in fact the ancients appear to have described it in that fashion. The *modern* understanding of such changes in the sky is that the axis of the earth's rotation is performing a twenty-six-thousand-year circle around the axis of the sun's yearly path against the background of the zodiac. (In the illustrations, the first of these axes is a line directed from the center of the celestial sphere — the point marked "observer" — to the point marked "north star"; the second would be a line directed from the observer to the "ecliptic north pole." Comparing the two spheres will show that the former is indeed circling the latter.) The cause of this so-called precession is a torque on the earth due to the gravitational field of the sun; but in any event, the result of the precession is the phenomenon at issue, for the precession causes a westward drift of the intersections between the "ecliptic" and the "celestial equator" — the gyroscopes, if you will, whose axes we have just pointed out. Note from the illustrations that these drifting intersections define the autumnal and vernal equinoxes.

posed of specific and recurrent tales, formulae, and motifs drawn from the mythology of virtually the entire globe. Her evidence overwhelmingly argues that in the preliterate, archaic cultures that coined them, these elements functioned as vehicles at once for expressing, for memorizing, and for transmitting certain kinds of astronomical and cosmological information. This should not amaze us. Consider that in our own living memory, a "story told" (the English equivalent of the Greek word *mythos*) enabled Polynesian navigators without compass, chronometer, and maps to effect pin-point landfalls hundreds of miles away, for such a story, by way of fictional narrative, connected the stars that rise along the eastern horizon of a boat crossing the Pacific in the proper direction. In a similar fashion, according to von Dechend, it is in the form of so-called etiological or explanatory myths, almost certainly versified (so it is here suggested), that early man acknowledged, and hypothetically sought to account for, certain flagrant violations of spatio-temporal parsimony and symmetry in the sky. Plainly such violations troubled not only ancient observers; witness the complaint of King Alfonso X of Castille, author of planetary tables published in A.D. 1252, that if God had but consulted him at creation he could have given Him some good advice.

Almost invariably (to judge from von Dechend's research), it is monstrous deeds — mutilations, incest, cannibalism, all of these inflicted by celestial beings upon their fellows — which keen observers felt logically driven to postulate as (at least generically) adequate explanations of discrepancies in the sky. Item: In many ancient civilizations, the inclination of the sun's (and the planets') path with respect to the planes in which the fixed stars diurnally revolve was taken as prima facie evidence of some earlier celestial disaster, much as we take a broken windshield on an automobile as evidence of some prior accident. Read in this context, the story that Kronos (Saturn) castrated his father Ouranos so as to separate "sky" from "earth" is plausibly taken as an attempt to account for the obliquity of the ecliptic (the yearly path of the sun) relative to the celestial equator. Similar stories were current in the ancient Near East, whose influence upon Hesiod, our earliest source for the Greek castration myth, is now generally recognized.

Item: The incommensurability of the solar and lunar years was explained in Egypt as the deliberate departure from an original 360-day cycle of twelve 30-day lunar months. In a game of dice, so the story goes, Mercury wins five days from the lunar year and adds them to the solar year (resulting in the present values of 355 and 365 days respectively). By doing this, he creates the extra days on which the planetary quintuplets can be born. For those children had been conceived in an incestuous union by the sky goddess Nut, and the sun had prohibited their birth "on any day of month or year."

Item: Consider the slow eastward slippage, past a fixed and ancient horizon marker, of the familiar constellations marking solstices or equinoxes, clearly noticeable after about 200 years and entailing the gradual obsolescence of any given polar star. (The illustrations on the facing page demonstrate the effect.) All one needed to notice this (in Professor Philip Morrison's apt phrase) was an old tree and faith in the veracity of one's grandfather. Obviously, a set of stone markers of the sort amply documented by Professor Alexander Thom's work would have done even better. Given these naked eye horizon phenomena, there is no empirical reason for down-dating the recognition of the slippage in question to the time (B.C. 150) when Hipparchus correctly traced the visible phenomenon at issue to the westward "precession" of the invisible intersection of the invisible celestial equator with the equally invisible ecliptic. After all, the correct explanation of a phenomenon commonly comes long after its routine observation. And for that matter even Hipparchus failed to provide the correct kinematic explanation — an explanation not furnished till Galileo.

There remains the standard objection that had the "precession of the equinoxes" been recognized by pre-Hipparchian astronomers, Plato would have allowed in his models for a second and slower westward motion of the celestial equator, additional to the diurnal one, and Eudoxus would have provided an extra rotating sphere to handle it. (Eudoxus attempted to model the planetary motions on a set of concentric spheres within the larger sphere of the universe itself.) This might be true if, as is not the case, the precessional phenomena had been correctly construed as cyclical, i.e. as due to the westward advance along the ecliptic of the point where the equator intersects the ecliptic. To judge by Plato's *Politicus,* however, the phenomena were construed as alternating or reciprocating, as if, to use a modern analogy, they were governed by a spring-driven mechanism, alternately wound up and running down. Besides, Eudoxus's concentric spheres were notoriously unequal to the task of accounting even for such relatively simple matters as the planets' variations in apparent size and luminosity and, in certain cases, for the retrograde motion of a planet across the sky.

Now Professor von Dechend has succeeded in identifying a number of mythological formulae and motifs which, if they are not patronizingly to be dismissed as the confused phantasies of childlike "primitives," make sense as hypothetical explanations of precisely this slow eastward drift of the solstitial and equinoctial constellations and the consequent periodic obsolescence of those cardinal points by reference to which we orient ourselves here on earth.

Take the story of how at the end of the so-called Golden Age the sun was displaced from his former path by the fact that Phaethon, the sun god's son, lost control of the solar chariot; or the story of how Zeus, disgusted by the cannibalistic dish fed him by Lykaon (who wished to test Zeus's omniscience), kicked over the table in horror. Both stories, so von Dechend shows, refer to successive phases of one and the same process, the gradual displacement of the familiar constellations marking vernal and autumnal equinox and summer and winter solstice by new constellations to the west of them. Thus Phaethon's Fall marked the end of the Golden Age, the great world age when the Milky Way, linking Gemini and Sagittarius,

had coincided with the sun's equinoctial place. The episode of Lykaon's dish marked the end of the next or Silver Age, when Taurus and Scorpio had replaced Gemini and Sagittarius as the constellations governing the equinoxes (and the north pole had, of course, shifted accordingly).

To be sure, the mythological language describing the eastward slippage of familiar equinoctial and solstitial constellations originally did so in terms of the corresponding naked-eye phenomena only, i.e. not in terms of the equator-ecliptic coordinate system, which, as we have noted, is a relatively late invention. Thus as a constellation hitherto marking vernal equinox dropped from sight beneath the eastern horizon, it could be said to "be drowned" or "drowning" in the "waters below," even while its successor "descended" to mark the equinoctial sun's new rising-point on the horizon, west of the point hitherto marked. Conversely, the old constellation marking autumnal equinox could be described as "ascending into the sky," even as its successor "climbed onto dry land" behind, i.e. to the west of it. (Again consult the pair of illustrations on page 86.) The translation of such language into terms appropriate to the equator-ecliptic coordinate system, when that did come in to use, meant, of course, a mere reversal of roles. It was now the equator which, by advancing westward along the ecliptic, entailed the "draining" or "emergence from the waters" of the new zodiacal constellation marking vernal equinox, while causing the old one to "ascend into the sky"; and likewise it was the equator's advance which "drowned" the old constellation associated with autumnal equinox while "bringing down to earth" its successor.

It is neither possible nor necessary here to rehearse these findings in detail. For the massive infrastructure of supporting data the reader is referred to Professor von Dechend's publications already available and forthcoming. Suffice it here to single out four corollaries only:

☐ The mythological motif of successive world ages to denote successive equinoctial constellations (not, of course, as witnessed by any one generation, but as an accumulated tradition or as inferred by simple backward extrapolation).

☐ The mythological motif of "catastrophes," usually floods or fires or both, opening and closing each of the world ages.

☐ The association of each world age with a planetary ruler, i.e. with one of the naked-eye planets, in an order varying inversely with the angular velocities of the planets across the sky. In particular, the radial distances of the planets were taken to be inversely proportional to their angular velocities. Thus, Saturn, the slowest of the planets, was taken to be the most remote, and also the oldest. And by this reasoning, Saturn was construed to have been the ruler of the most ancient world age, the Golden; the planet was displaced outward to its present position by the planetary rulers of subsequent ages.

☐ Finally, the concensus, virtually universal among ancients as different as the author(s) of the Babylonian creation epic and the far later writers Solon, Herodotus, Caesar, Plutarch, and Tacitus, that the "true" identity of a foreign deity can be deduced from its attributes. Thus, the deities in charge of the upper, middle, and lower portions of the sky and those in charge of the several naked-eye planets in one culture are almost always unhesitatingly translated into those familiar to another. Witness, for example, the functional identity of what the Babylonian epic terms the Ways of Enlil, Anu, and Ea with what Greek mythology distinguishes as the realms of Zeus, Poseidon, and Hades — namely the upper, middle, and lower sky, or, in a metaphorical variant, the bright vault of the sky; the earth and its supporting waters; and the underworld, the unseen bottom of the sky. Witness, too, the functional identity of the Babylonian God Enki-Ea with the Greek Kronos and the Roman Saturn. Solon's "translation" of deities mentioned to him by Egyptian priests will presently prove to be a case in point.

In the remainder of this article, we propose to reconsider Plato's Atlantis myth in the light of these four corollaries. The story itself is distributed by Plato over two dialogues, the *Timaeus* and the *Critias*, both set in B.C. 421 (when Plato himself would have been seven). In the first, the grandfather of Plato's maternal cousin (both are named Critias) tells the story in summary form, by way of a preamble to Timaeus's long account of cosmology, astronomy, physics, and biology, all of this cast in the form of a cosmogonic myth. Critias (Plato's cousin's grandfather) explains that the story of Atlantis reached him by word of mouth from *his* ancestor, Solon, and that Solon had heard it (probably, one would guess, soon after B.C. 570) from Egyptian priests at Saïs, in the Nile Delta. It has been claimed, we should note, that these details about the pedigree of the story constitute a mere literary device, meant to get us to accept a myth (a "probable story": *eikos logos*) that Plato himself has invented. But why should Plato have hoped to deceive his readers in that way? Athens was small, Plato's family was large, and Plato was an aristocrat with a reputation for veracity to protect. We have good reason, then, to accept Plato's assurances that Solon heard the story in Egypt.

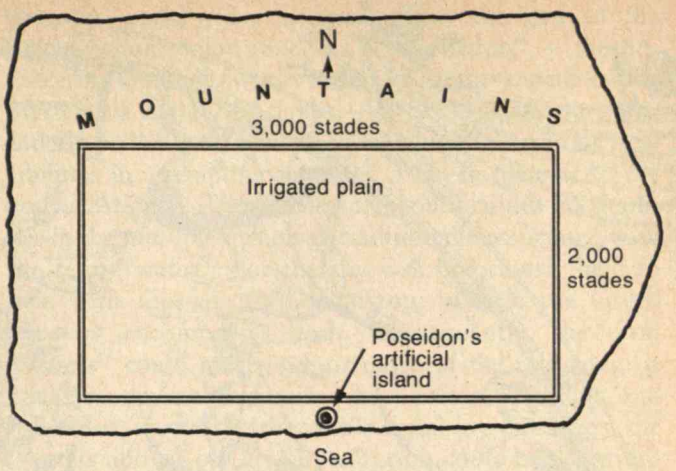
In the second dialogue, Critias is the only speaker. He tells in detail what prehistoric Athens and Atlantis were like, but then unaccountably breaks off his narrative.

Very briefly, the story is this: Nine thousand years before Solon's visit to Saïs, the gods took charge of and peopled their appropriate allotments of the earth. Athena and Hephaestus jointly got Athens; Poseidon (or at least the Egyptian god whom Solon equates with the Greek "Poseidon") got the large island of Atlantis — an island beyond the pillars of Hercules, vulgarly taken to be the Straits of Gibraltar but even in that meaning suggesting the limits of the known world. A millennium later, Athena got Saïs. To isolate and protect the mountain top on which he mated with a mortal woman on the island of Atlantis, Poseidon created an island within an island by ringing the mountain with five concentric bands, two of them moats. After his five pairs of twin sons had come of age, he distributed the larger island among nine of them but reserved his artificial island and the belt of land surrounding it, which was largest and best, for his first born

son, Atlas (who in Egyptian as well as Greek mythology kept sky and earth apart). Poseidon made him king over the other nine "rulers" *(archontes);* and at that point Poseidon presumably withdrew, because no more is said about him. After "many generations" the governance of Atlantis developed the nation into a vast naval empire ruling the lands up to (but presumably not initially including) Egypt and Tuscany. Trade, natural fertility, and the mining of metals combined to produce enormous wealth, which enabled Atlas's descendants to add an extra ring of land to the central island, to build walls around each of the four resulting circular areas of land, to run a navigable canal straight from the sea to the central island, to build a costly temple to Poseidon in the center, and to develop into an enormous, irrigated rectangle the arable portion of the larger island. The ten ruling princes also convened assemblies in Poseidon's sanctuary at five- and six-year intervals. On these occasions they hunted a sacred sacrificial bull, armed only with wooden sticks and nooses.

"Many generations later," however, as their admixture of divinity grew ever feebler, the rulers of Atlantis succumbed to lawless ambition and power. Whence Zeus decided to teach them a lesson so that they would mend their ways. Here Plato's *Critias* breaks off. But we know from earlier hints (*Timaeus* 25 B., D.) that two events then occurred. Trying to capture the whole Mediterranean in a single eastward sweep, the Atlantid forces were defeated by prehistoric Athens in a war so long that it involved at least four successive mythical kings of early Athens (Cecrops, Erechtheus, Erichthonius, and Erysichthon (*Critias* 110A). So much, presumably, for Zeus's attempt to bring the ten rulers of Atlantis to their senses. That was 9,000 years prior to Solon. At an indefinitely later time, however — the lesson presumably not having been learned — Zeus sent (or authorized Poseidon to send) earthquakes and floods, which in one terrible day and night drowned not only the entire island of Atlantis, rulers and all, but also the occupying Athenian army and navy (*Timaeus* 25D). At the same time torrential rains swept away much of the soil, and so altered the climate, of prehistoric Attica (*Critias* 112A).

The history of the interpretations of this myth can be arranged along a spectrum. At one end (1) are those who claim that the story is literally true; at the other end (4) are those who claim that it is either a purely decorative fiction or one that, at least in its original form, reflects Egypt's foreign political aim of securing an Athenian alliance against Persia. Between these two extremes fall two intermediary positions. First, there are (2) those who, besides crediting the myth with historical truth, take it to symbolize in addition the allegedly timeless truth of Plato's distinction between a finite set of fixed, purely intelligible archetypes underlying all of reality, on the one hand, and the infinite, ever fluctuating variety of their physical embodiments, on the other (so the ancient Neoplatonists Iamblichus, Syrianus, Proclus). For the historical basis, the advocates of position (2) seek a geographic referent (2a) outside Gibraltar (anywhere from Spitsbergen to America) or (2b) inside the Mediterranean



The island of Atlantis, bestowed upon Poseidon (according to Plato) when the gods apportioned heaven and earth among themselves at the end of the Golden Age. The island includes an irrigated plain — irrigated, at least, by Poseidon's descendants — measuring 3,000 by 2,000 "stades" (a stade is 606.75 feet). Poseidon himself, to protect the place where he mated with a mortal woman, constructed on Atlantis a sanctuary within five concentric bands alternately of earth and water. This island-within-an-island appears at the bottom of this large-scale drawing, and in greater detail on page 96. One further detail: the eastern side of Atlantis comes to a tip — a tip said by Plato to point toward the "pillars of Hercules."

(e.g. on the site of the present, approximately circular, Santorin group of islands). Then (3) there are those who, while denying any historical basis, see the story as an allegory (3a) of the nature (astronomical or eschatological or both) of the universe, or (3b) as a fictional projection into prehistory of what in the *Republic* was described by Plato as utopia.

Those favoring a location for Atlantis outside Gibraltar (2a) can appeal to Plato's express language (*Timaeus* 24E). Those favoring a location inside the Mediterranean (2b) can appeal to the historical seaquake which about B.C. 1200 destroyed Crete, if at the price of the auxiliary postulate that Solon (or his informants), in translating the Egyptian numerals concerning date and size of Atlantis, mistakenly inflated them by a factor of ten. Finally, those favoring only a fictional, utopian interpretation for Atlantis (3b) can cite what by Plato's own admission (*Timaeus* 26E) is the "strange parallelism" between the utopian Republic and early Atlantis.

Several of these intermediary views are compatible, of course. Thus, an Egyptian cosmological account, originally encoded in story-form and involving "Athens," could well have been furnished Solon for a political reason additional to that of impressing him with Eygpt's hoary antiquity. And Plato, in editing this tale, could perfectly well have chosen to suppress some aspects of the story in favor of political, and above all cosmological, ideas of his own. With these modifications, Alexander von Humboldt's view that Plato quite possibly made use of native Eygptian myths retains its plausibility. In any event, the traumatic folk-memory of the seismic catastrophe of B.C. 1200 may well have colored Plato's de-

The southern sky as depicted by Jan Hevelius in an atlas of the heavens published in 1687. The Milky Way (though not explicitly shown) streams more or less vertically in this illustration. It flows between Scorpio and Sagittarius at the top of the circular projection, and then past Ara, an altar here depicted as aflame. Toward the bottom of the illustration, it flows behind the head of Canis Major and then passes Orion near the perimeter of the circle. The poop of a ship (the constellation Argo) appears to be afloat in this milky river; the star α Carinae, or Canopus, second brightest in the sky, is the most prominent of the two stars defining the rudder of the ship.

scription of Atlantis's end — without the latter catastrophe being reducible to the former.

That granted, the point of the following pages is to call attention to a body of evidence which argues that, among much else, we have here an etiological myth concerning the succession of astronomical "world ages."

The doctrine of the world ages occurs as early as the Babylonian *Enuma Elish* ("When above . . . ."), dated to the middle of the second millennium B.C. It has analogues in Iran, Greece, Rome, the Norse Edda, and elsewhere. We have already had occasion to note that it represents the slow eastward drift of equinoctial constellations in the sky. Consider now the mythological explanation devised to account for the role of so conspicuous a swath of sky as the Milky Way, linking Gemini and Sagittarius by way of a luminous bridge. A simple backward extrapolation would have sufficed for the ancients to have established a period in the still more distant past (from about B.C. 6000 through B.C. 4000) when this bridge still coincided with the sun's place at dawn and dusk on the equinoctial days of the year, i. e. when the equinoctial sun would have been seen to rise and set in the constellation of Gemini in the spring and Sagittarius in the fall.

What, in retrospect, made this period appear "golden" was that gods and men were believed to have communed by way of the bridge. Accordingly, when the Milky Way had ceased (about B.C. 4000) to overarch the equinoctial points, this was interpreted as the end of the Golden Age and, by that token, as the start of a steady decline of which the calamities of the ancients' own age, that of Iron, were but the ultimate consequences.

The Golden Age was the period in which the universe acquired its initial shape. Consistently, therefore, the planetary ruler of the Golden Age — namely Saturn (Kronos in Greek) — is in virtually all mythologies conceived as the Engineering God *(Deus Faber),* responsible not only for the fathering of his planetary successors but also for the original design and realization of cosmic order. Now aside from genealogically linking the younger to the older gods, the myth-makers among the ancients had treated each world age as self-contained and as opening and closing with some catastrophe. Plato, however, shared the Pythagoreans' commitment to strict logical coherence and its corollary, a purely deductive model of truth and reality. He therefore retained the myth of world ages as introduced by a Saturnian Demiurge, but recast it in such a way that what formerly had been the products of random, if successive, catastrophes now appeared as the necessary consequences of what had been implicit in the initial conditions. Thus, although, or precisely because, in the *Timaeus* the basic frame of the universe is traced to a divine engineer possessing all the earmarks of Saturn, the obliquity of the ecliptic is presented not as the result of a struggle (much less a castration, as we mentioned earlier) but as itself part of the initial design.

To this extent, then, Plato is undoubtedly original when in the *Timaeus* he has the Demiurge peacefully engineer what we understand as the equator-ecliptic coordinate system. At the same time, however, the notion of an Engineering God is demonstrably part of an older, apparently world-wide, tradition. Thus the god of the *Critias* whom Solon rendered as "Poseidon" — the Engineering God who works elaborate improvements on the mysterious island of Atlantis — evokes specific parallels. Indeed, Solon must have been faced with numerous possibilities in attempting to assign a Greek identity to the god of Atlantis. The essence of his difficulties no doubt lies in the multiple meanings traditionally associated with the term "water." For the sky was notoriously held to fuse with the sea at the horizon, whence the Greek *okeanos* encompasses both. Consequently, the term "waters" could mean one or more of the following: it could be the sea as familiar to a nation of sailors and fishermen; it could be the visible sky above our heads (the "waters above" of *Genesis* 1:7); or it could be the invisible sky beneath (the "waters below" of *Exodus* 20:4). Upon the banishment of Kronos/Saturn at the end of the Golden Age, Poseidon received the first of these, Zeus the second, and Hades the third. Complicating this problem is a further linguistic convention of archaic astronomy: the half of the ecliptic extending beneath the celestial equator was termed "wet" or "water"; that extending above the equator was termed "dry" or "earth"; and by this token, westward motion along the ecliptic carries one into "the waters below." Such, in fact, is the route taken by the souls of the dead on their voyage to the underworld; and such is the route which someone like Odysseus must take, even while living, if he wishes to visit there. At the southernmost point of the ecliptic (i.e. at the point on the ecliptic deepest into the "waters") lies the constellation marking winter solstice. This is the portal to the underworld. Upon arriving there, souls and visitors alike must presumably turn south to reach their destination in the unseen sky.

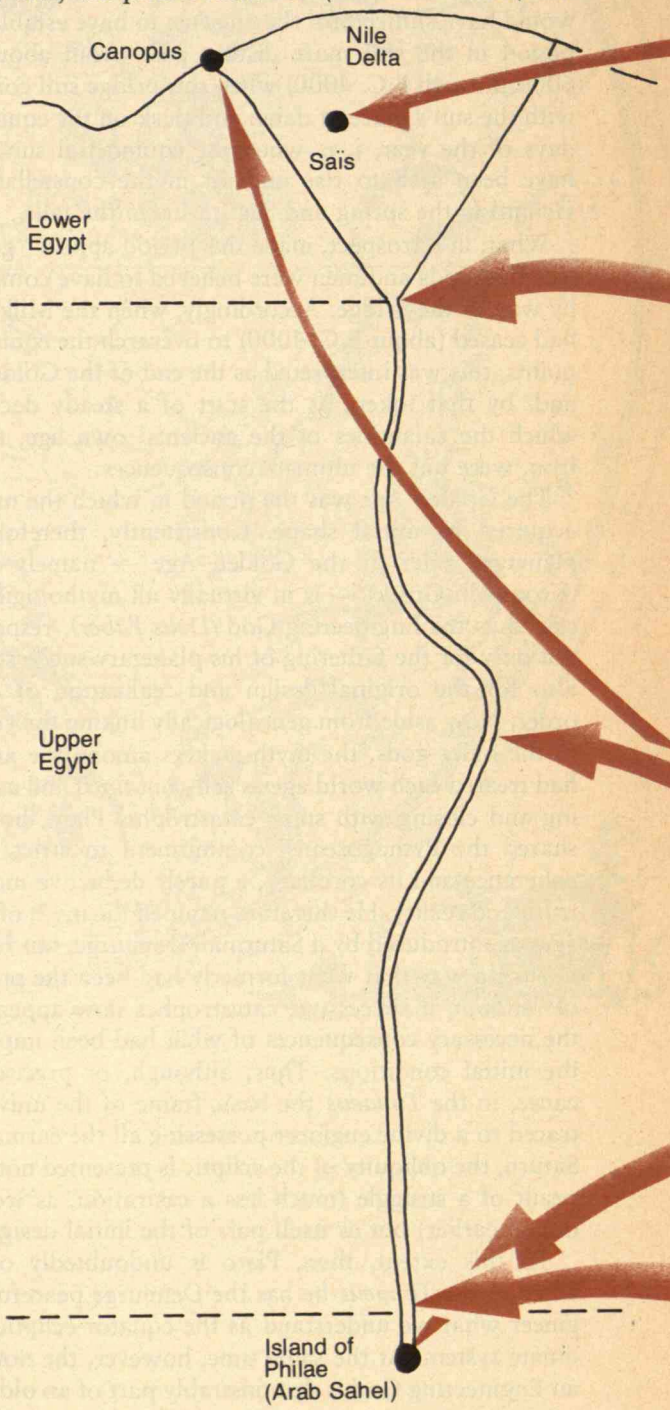
Recall, now, that the island of Atlantis lies "in front," i.e. outside or to the "west," of the pillars of Hercules (*Timaeus* 24E). Quite plausibly, then, that island is Poseidon's. For westward motion on earth, or on the ecliptic, places the island in a watery realm. Of course, the interpretation of "westward" in celestial terms requires that the "pillars of Hercules" be taken to refer not to Gibraltar, but instead to some suitable celestial analog, say the equinoctial points or perhaps the tips of the horns of Taurus. However, there are other possibilities for Atlantis. Westward along the ecliptic is also southward, and hence an excursion into the area normally associated with Hades. On that view the island would be in *his* realm. There is, moreover, the fixed association of Kronos/Saturn, at the close of the Golden Age, with banishment to an "island" at or near the celestial south pole, i.e. at a specific place within the underworld — an island on which Kronos sleeps while time stands still. It is interesting to note that Enki-Ea, the Babylonian Kronos, dwelt in the "town of Eridu at the confluence of rivers" — a place which remained a geographic mystery until, a generation ago, Van der Waerden could demonstrate the identity of Eridu with Canopus, the bright star in the southern sky nearest to the southern pole of the ecliptic. More about that later. The point for now is that the island of Atlantis could plausibly be the same as the island to which

Kronos/Saturn is traditionally relegated.

One further association is possible. Atlas's island is reported by Hesiod (*Theogony* 517-20) to be to the west (near the Hesperidae), and by both Homer and Hesiod to be the place where Atlas upholds the sky, either by guarding the cosmic axis (so Homer) or by supporting it on his shoulders (so Hesiod). On either view, the island of Atlantis would again be at or near the celestial south pole — the more so if we can equate the island of Atlas with that of his daughter Calypso, for the latter island is expressly said by Homer (*Odyssey* I 50-54) to be "at the navel of the sea," i.e. at the deepest point of the "waters."

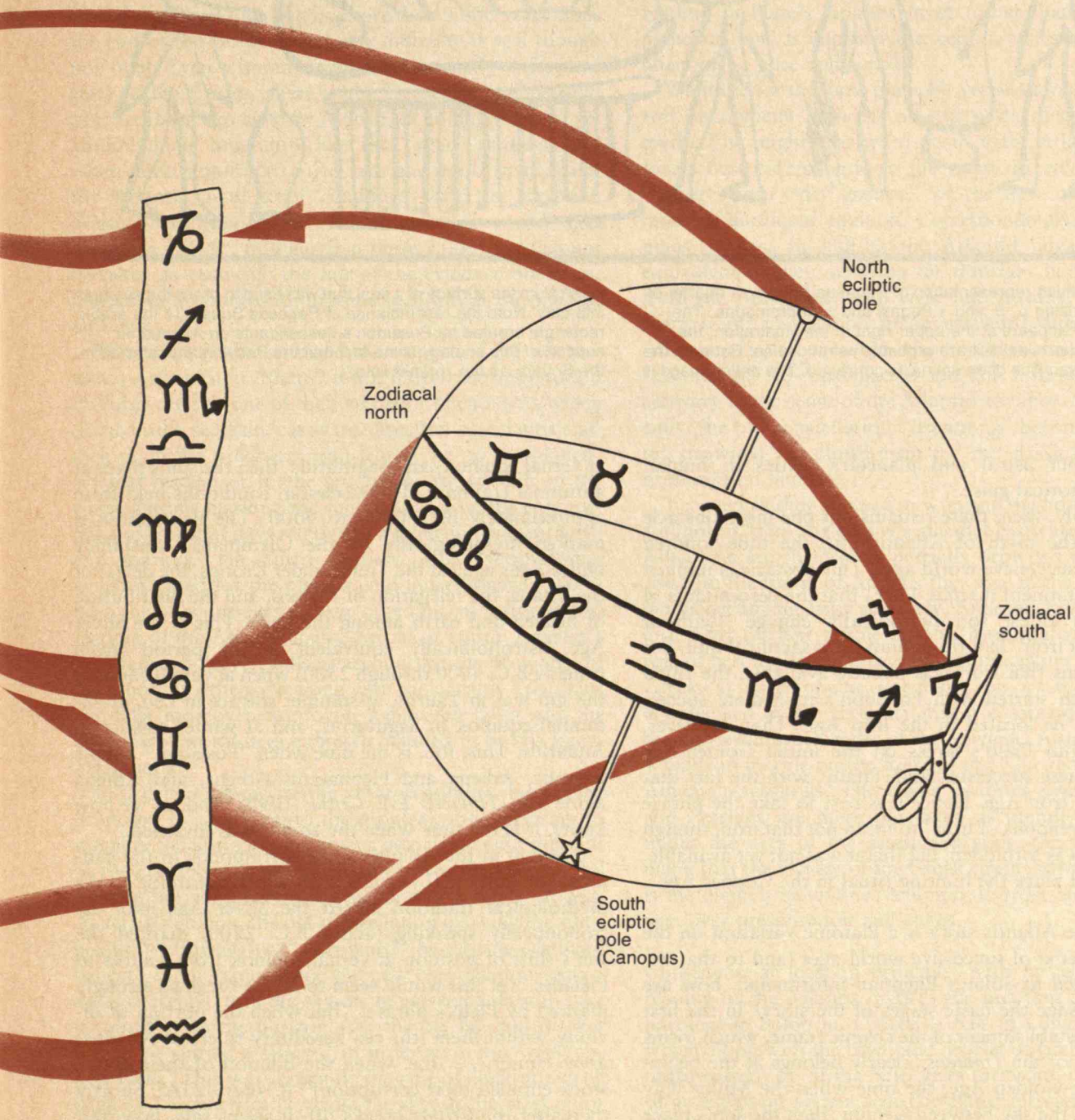
One sees, then, that to a Greek, the Egyptian deity responsible for Atlantis was bound to combine aspects of Poseidon (lord of the sea, and indeed dwelling in its depths [*Iliad* XIII 21]), Hades (lord of the underworld), Kronos (dwelling upon an island where time stands still), or Atlas (dwelling, it seems, at "the navel of the sea"). Under the circumstances, Solon may be pardoned for provisionally settling upon Poseidon. Yet if, as here suggested, the Atlantid "Poseidon" is also a variant of Kronos/Saturn in his role as Engineering God, then the doctrine of the world ages, detailing among other things the accession and relegation of Kronos, is very likely to have left its traces on the story of Atlantis.

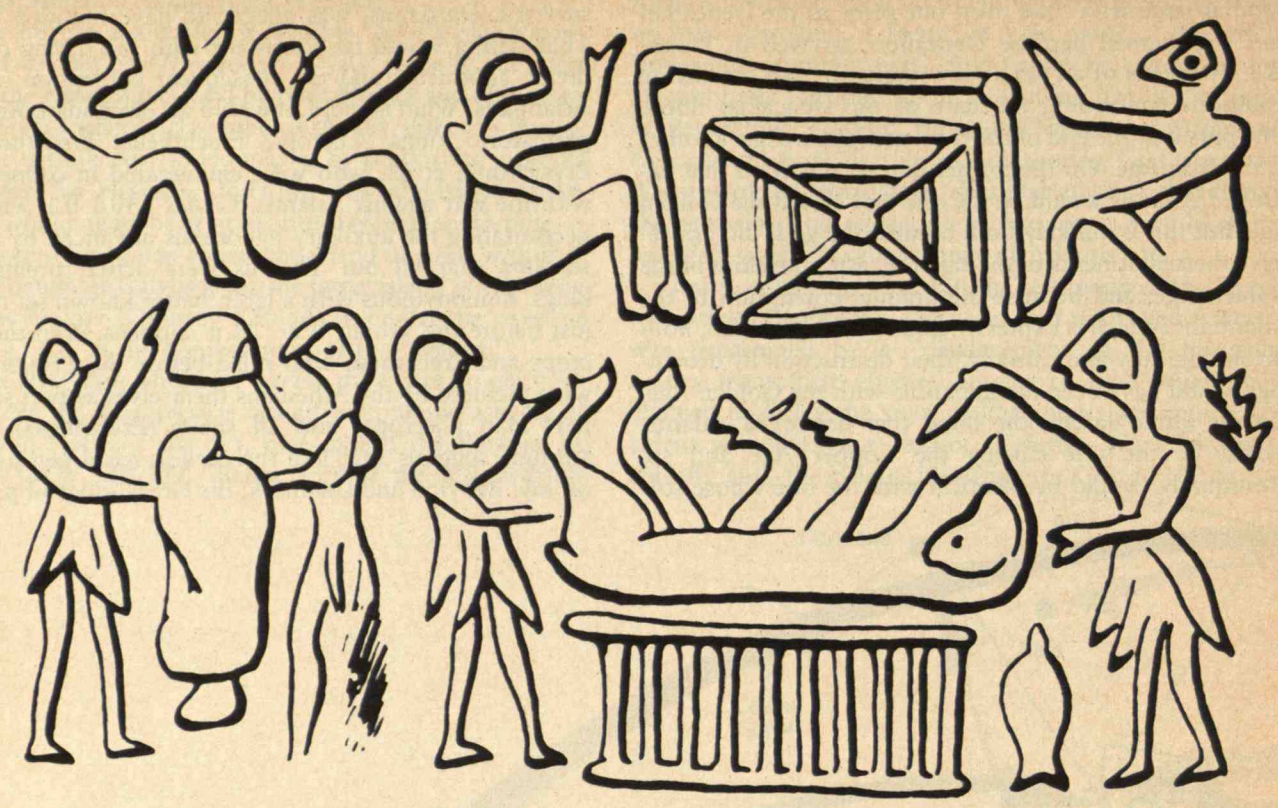
That is in fact the case. On the testimony of the Egyptian priests themselves, the flood that destroyed Atlantis was occasioned by a "displacement of the heavenly bodies from their course" similar to that which they claimed underlay the story of Phaethon's age-ending accident with the solar chariot (*Timaeus* 22). More specifically still, the priests identified (in *Critias* 112A) the



A system by which the ancient Egyptians correlated locations in the sky with locations on earth. In the rightmost part of the illustration, the band of the zodiacal constellations is shown, together with its central axis, terminating in the north and south poles of the ecliptic. The south pole is marked by the star Canopus. The modern constellations of the zodiac have been placed on the celestial band, solely to demonstrate the nature of the projection system at issue; those constellations do not represent the way the Egyptians would have construed the sky, and in any case they are shown in their modern positions, with Capricorn, for example, at the southernmost point of the ecliptic — the point of winter solstice. Now the nature of the celestial-terrestrial mapping shown in this figure was elucidated by Georges Daressy, who analyzed an Egyptian zodiac — specifically a zodiac represented along the architraves of several Egyptian temples as a sequence of animals. Below such sequences is a geographically accurate representation of the Nile, which alone would suggest a one-to-one mapping of sky to earth. However, Daressy also knew that particular townships along the Nile had as their emblems the same or similar animals. Note that the zodiac in the illustration is cut at its southernmost point, and that the resulting linear sequence of constellations is mapped only onto the portion of the Nile south of the Nile Delta — the portion in Upper Egypt. If the Egyptians mapped the zodiac onto the Lower Nile, the details of that mapping remain to be discovered. Note also that several further aspects of the Egyptian association of the sky with the earth are shown in the illustration: The south pole of the ecliptic is mapped onto the island of Sahel, but it is also mapped onto the earthly town of Canopus, at the westernmost point of the Nile Delta in Lower Egypt. The north pole of the ecliptic is mapped onto Saïs in the Nile Delta.

flood at issue with "the third one prior to the Deucalian one" (so named because Deucalion survived it, Noah-like, by means of an ark). Now there are two conflicting traditions concerning the date of the Deucalian flood. One puts it at the end of the third or Copper Age, another in the Iron Age. On the former dating, the flood that destroyed Atlantis would be the one that closed the Golden Age. But this is unlikely both because the gods did not receive their allotments of the earth till after the close of the Golden Age, and because the gradual corruption of the Atlantians (which is expressly said to have preceded, both chronologically and causally, their destruction by drowning) would have been incompatible with the Golden Age. On the latter dating, the flood that destroyed Atlantis would be the one closing the Copper Age and so, presumably, would be identical with the one whose sole survivor, Dardanus, was alleged to have founded Troy. That dating would be consistent with the dating of the divine allotments and the subsequent corruption of the Atlantians. What is more, it would accommodate Athens' prehistoric kings, Cecrops, Erechtheus, Erichthonius, Erysichthon et al., who were enumerated in connection with the war against Atlantis (*Critias* 110A ff.), without necessitating the auxiliary hypothesis advanced by some scholars that all but Theseus were actual prehistoric kings, homonymous with a later, better known set ruling just before the Trojan War. As it happens, even the Cecrops and Erechtheus who ruled before the Trojan War were pictured by the Athenians themselves as part snake, part man (Cecrops) and all snake (Erechtheus). This strongly suggests that like the earliest royal genealogies of, say, Babylon and Denmark, the Greek kings of prehis-





A Mesopotamian representation of Pegasus Square, a quartet of starts comprising α, β, and γ Pegasi and α Andromedae. The square itself appears at the upper right of the illustration; the beings to either side of it are probably astral deities. Beneath the square, the sacrifice of an animal is portrayed. The entire image is taken from the surface of a seal that was used to press the symbols into clay. Note the resemblance of Pegasus Square to the arable rectangle created by Poseidon's descendants on Atlantis. In support of this analogy is the fact that the Babylonians referred to the Square as the "primal field."

tory are but astral and planetary deities in human pseudo-historical guise.

Ostensibly, then, there remains but one more obstacle to fitting the myth of Atlantis into the time-honored scheme of successive world ages. This obstacle is implicit in Plato's statment (*Critias* 119E) that the descendants of Poseidon's eldest son periodically engage "without weapons of iron" in a ritual hunt for a sacrifical bull. For if this means that iron was already available, the ritual hunt (which started with Poseidon's immediate successors) must be located in the Iron Age. That, however, conflicts with Plato's stress on the initial Golden-Age virtue of these successors and, fatally, with the fact that *ours* is the Iron Age. Hence it is best to take the phrase "without weapons of iron" to mean not that iron, though available, was forbidden, but that it was not yet available. This would place the hunting ritual in the Copper Age.

If, then, the Atlantis story is a Platonic variation on the familiar theme of successive world ages (and to that extent indebted to Solon's Egyptian informants), how are we to envisage the basic stages of the story? In the first place, the establishment of the cosmic frame, which forms the subject of the *Timaeus,* clearly belongs at the beginning of the Golden Age, the time when the Milky Way overarched the sky between Gemini (then the sun's place at vernal equinox) and Sagittarius (then the sun's place at autumnal equinox). These celestial conditions held from approximately B.C. 6000 to 4000. The next phase is marked mythologically by the Olympians' conspiracy under Zeus against the Titans under Kronos, the defeat of the Titans, the relegation of Kronos, and the distribution of heaven and earth among the gods. This is the Silver Age, astronomically equivalent to the period (from roughly B.C. 4000 through 2500) when at vernal equinox the sun was in Taurus, at summer solstice in Leo, at autumnal equinox in Sagittarius, and at winter solstice in Aquarius. This, too, is the time when "Poseidon" adopts Atlantis, Athena and Hephaestus Athens, and Athena alone Saïs (*Timaeus* 23E, *Critias* 109B). And, as we now know, it is the time when the zodiac was invented.

Nothing in the Atlantis story corresponds to the cannibalistic outrage (Lykaon's dish) which according to the mythological tradition closed the Silver Age and, astronomically speaking (about B.C. 2200) marked the sun's shift of position at vernal equinox from Taurus to Pleiades. Yet this would seem to be the break so strongly marked by Plato's phrase, "But when the portion of divinity within them [the ten hereditary rulers of Atlantis] grew fainter. . . . [i.e. when the dilution of their divine stock entailed their corruption]" (*Critias* 121A). Shortly thereafter the *Critias* breaks off. It seems safe, however,

to infer that this corruption expressed itself, among other ways, in the unsuccessful attempt to conquer the Mediterranean world (*Timaeus* 25C), and that the Atlantid leaders' failure to learn the lesson of this defeat (where the Athenians figured as instruments of divine vengeance) caused Zeus to send (or authorize) the flood that indiscriminately destroyed both the entire island and the presumably occupying Athenian forces as well. Astronomically speaking, the flood would seem to have coincided with the sun's shifting (about B.C. 1300) of its place at vernal equinox from Pleiades to Perseus.

Yet how does Plato's repeated statement that no fewer than 9,000 years have lapsed since the events of the myth square with the fact that on the astronomical grounds we have described, no more than 700 years can have lapsed since the Trojan War, no more than 1,630 years since the end of the Silver Age, and no more than 3,400 years since the end of the Golden Age? The difficulty is real though not fatal. Even without citing the manifestly unfinished state of the *Critias,* there is the Egyptians' well-known practice, long ago cited by Martin, of adding unequal yet homonymous time-units like the "year" ranging anywhere from a month to a true year and more. In any case, the Atlantis myth itself combines with the Egyptian priests' own allusion to the doctrine of world ages (*Timaeus* 22C ff.) to argue that these 9,000 years cannot be taken to outweigh the rest of the evidence but must, instead, be accounted for in some such way as the one just outlined.

What then is the astronomical import of the war between Atlantis and Athens? If it is indeed astronomical, it can only refer to one of the two major phenomena which occur in the requisite eastward direction of Atlantis's attack upon the Mediterranean world, viz. to the planets' sidereal motion or to the gradual eastward shift of the constellations marking the sun's position on the equinoctial and solstitial days relative to a fixed and ancient horizon marker. The third century A.D. Neoplatonist Amelius opted for the planets, and indeed seems to have been the only one ever to have opted for an astronomical reading of the Atlantis myth, partial or entire. Amelius's preference, however, fails to account for the drowning of the innocent Athenians along with the corrupt Atlantians and fails, moreover, to provide a plausible tie-in with the doctrine of world ages expressly alluded to by the Egyptian priests.

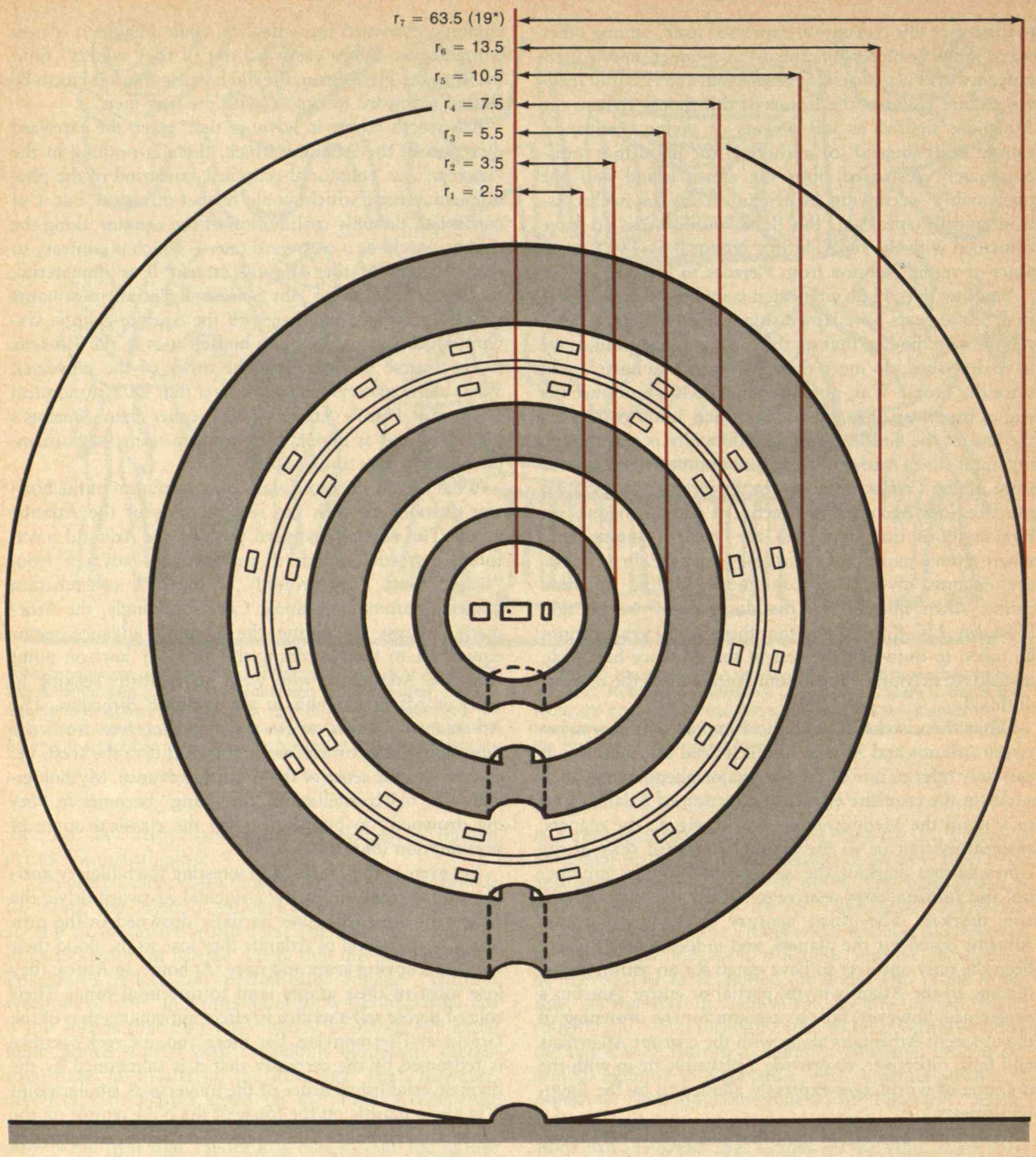
In order to appreciate the other possibility, here being proposed as a solution to the problem, it is necessary to visualize the horizon-phenomena associated with the shift of the constellations at issue, and to see the eastern and western horizon phenomena as parts of a single process. At vernal equinox, the old constellation marking the sun's position "drowns" or "is drowned" by moving eastward beneath the horizon, while the new constellation replacing it descends from the sky on an eastward slant to take its position on the horizon. Yet the old horizon marker has to be shifted *westward* in order to accord with the new facts. (This was shown by the pair of illustrations on page 86.) Diametrically across the sky, at the marker for autumnal equinox, the old constellation appears to be climbing eastward into the sky, while behind it a new constellation climbs eastward out of the "waters" onto the horizon. Here again, the old horizon marker has to be shifted westward to accord with the new facts.

It is worth noting in advance that, given the eastward direction of the Atlantid attack, there is nothing in the "correct," i.e. equatorial-ecliptical, construal of the phenomena at issue which would fit that direction. For if so construed, the only real motion of the equator along the ecliptic would be a westward one — which is contrary to the direction of the Atlantid attack. It is immaterial, therefore, whether or not Solon's Egyptian informants may be presumed familiar with the equator-ecliptic system (which, of course, Plato himself uses in the *Timaeus* in the course of describing the order of the universe). What alone matters here is the fact that an astronomical reading of Plato's Atlantis myth (other than Amelius's planetary one) is impossible except in terms of horizon-phenomena pure and simple.

What then is the most plausible correlation of the horizon phenomena with the several parts of the Atlantis myth? The mighty eastward push of the Atlantid naval forces best corresponds to the eastward advance from "water" onto "dry ground" of the new constellation marking autumnal equinox. Correspondingly, the Athenians' success in halting the Atlantid advance seems equivalent to their wresting the fiduciary horizon point from the Atlantians, who were hubristically seeking to carry it off in triumph in an eastward direction. The Athenians in effect wrest their marker free from the "drowning" old constellation and shift it to the west, i.e. contrary to the sense of the Atlantid advance. Mythologically, the old constellation "drowning" becomes its "being drowned" in punishment for the classical crime of presumption (*hubris*).

Yet even as they succeed in wresting the fiduciary horizon points from the enemy's suicidal eastward drive, the Athenians are themselves partially drowned in the process. On the island of Atlantis they lose to the flood their whole occupying army and navy. At home, in Attica, they lose most of their arable land to torrential rains. Their role of heroic self-sacrifice in effect anticipates that of the Greeks at Thermopylae. For there, too, a Greek sacrifice is redeemed by the certainty that it is sanctioned by the divinely established order of the universe. A similar point is made in marble on the frieze of the Nike temple on the Athenian acropolis. The Greek victories over Amazons and Persians are there portrayed as literally occurring under the eyes of the assembled gods, the implication being that the victory of the Greek cause, however costly, is the divinely sanctioned triumph of order and moderation over presumption and chaos.

Consistent, at least in principle, with an astronomical reading of the Atlantis myth is the fact that the myth is narrated to Solon in a place — Saïs in Lower Egypt — which along with the town and district of Canopus at the northwestern tip of the Nile Delta forms an integral part of an Egyptian system that correlated terrestrial and celestial locations. Following a Mesopotamian analog, the



Poseidon's constructions on the island of Atlantis, as specified by Plato in the *Timaeus* and the *Critias*. Poseidon is reported to have created a series of rings, two of land and three of water, around an innermost island. Beyond that, Plato gives few details. Still, we are told of an altar on the innermost island, and also of a Temple of Kleito and Poseidon (Kleito is the mortal woman with whom he mated). The temple is said to be "at the center." Moreover, we are told that a metal pillar with Poseidon's laws inscribed thereon was "near the center of the island in the temple of Poseidon." The design shown here for the innermost island is patterned in large part on the Aphaia temple of Aegina, an island near Athens. The temple is indeed at the center; the pillar is within, though not quite at the precise focus of Poseidon's constructions (a statue of Poseidon is presumed to occupy that place). To the east of the temple is the altar; to the west is a palace. Additional features of Atlantis, added by Poseidon's descendants, include an "equestrian race-track" and "barracks for the greater part of the spearmen" on the second annular band of land. There is, in addition, a canal linking the central island with the sea, and passing beneath covered arches, shown here by dashed lines. The radii defining the concentric bands of Poseidon's work are given at the top right of the illustration; they are the values set by Poseidon himself, and are expressed in stades. * The outermost band of earth was constructed not by Poseidon but by his descendants. It is shown here as if its radius were 19 stades, which is the appropriate value if, as explained in the text, each radius ought to be larger than the preceding radius by a factor of $\sqrt{2}$. Poseidon's descendants, however, gave it a radius of 63.5 — more than three times too large for the scheme established by the builder of the island.

Egyptians construed their watery lifeline, the Nile, as a projection of specific segments of the sky, correlative and, at certain points, homonymous with celestial objects. Thus the references in the Babylonian creation epic to Eridu and Esagil are known to refer not, or not only, to the geographical places so named but also to stars, viz. Canopus, the bright star near the southern end of the ecliptical pole, and also Pegasus Square, a quartet of stars (α, β, and γ Pegasi and α Andromedae) describing a square whose heliacal rising marked (from B.C. 6000 through 4000) winter solstice. Similarly, in the (admittedly late) Egyptian temple of Dendera, the Upper Nile is taken as a projection of the zodiacal belt. To understand the projection, imagine the zodiac as inscribed on a circular band of paper. Cut the band at its southernmost point. The zodiac is now a long strip of paper with zodiacal north in its middle and zodiacal south at both of its ends. (See the figure on pages 92-93.) Perhaps it is no longer quite so curious that zodiacal south coincides at once, in the Egyptian system, with the southern *and* the northern end of the Upper Nile. The principle of celestial geography involved undoubtedly antedates its application to the zodiac. Elsewhere, the same principle is applied to the Lower Nile, necessarily in much greater compression. Here the town and district of Canopus at the northwestern tip of the Delta and an island in the extreme south of Upper Egypt are both taken as terrestrial equivalents of Canopus, while the town and district of Saïs, southeast of Canopus, is "hieratically [in priestly parlance]" (so Proclus) taken to represent the north pole.

Now it is at Saïs, the terrestrial representative of the north pole, that the Atlantis tale originates. And it is (as we shall now see) to Canopus and the southern circumpolar area of the sky that the story seems actually to refer.

Much favors the working hypothesis that Poseidon's artificial island (within the larger island of Atlantis) is in fact to be sought in the vicinity of the south pole of the ecliptic. In the first place, the ecliptic south pole was thought to be marked by the star Canopus and to be immune to the passage of time; it is the "island" to which Kronos/Saturn was banished upon his downfall at the end of the Golden Age — the island upon which Kronos sleeps while time stands still. And indeed, being near the south ecliptic pole, Canopus is in truth more or less immune to the passage of time — astronomical time. It is more or less immune, that is, to the drift of stars and constellations that entails the succession of world ages. Consider now Plato's express statement (*Critias* 119E) that near the center of the artificial island in Atlantis was a metal pillar upon which Poseidon's ten immediate descendants had inscribed his laws, and where they and their successors periodically assembled. It was over this pillar that the throat of a sacrificial bull was cut at such assemblies — the more appropriately so if the pillar was (or represented) the cosmic axis at its southern pole and the offering, the bull, represented the constellation Taurus. For the Silver Age, to which we have tentatively assigned this portion of the Atlantis tale, was the time when the rise of the constellation Taurus marked the arrival of vernal equinox. That the pillar is indeed the cosmic axis is independently suggested by Homer's resting the axis of the universe on Atlas's island, presumably "at the navel of the sea." (Recall that Poseidon gave over the rule of his artificial island to his first-born, Atlas.)

Numerous further features of the tale of Atlantis also appear to reproduce specific features of the southern circumpolar sky. Consider that what the Babylonians termed "the confluence of rivers," the place where Enki-Ea, the Babylonian Kronos, dwells, is the joining in this portion of the sky of the two arms of the Milky Way: one appearing to stream down past Orion, Sirius, and Canopus; the other funneling down through the gap guarded by Scorpio and Sagittarius, and then past the Altar (Ara), usually depicted as flaming or smoking, where the Olympians are reported by Eratosthenes to have sworn their oath of allegiance to Zeus before setting out to battle the Titans and depose Kronos — the events that ended the Golden Age. There is, moreover, the poop of a ship, Argo, elaborately equipped with sails and oars (Canopus being the rudder), which seems to be sailing along an arm of the Galaxy. (Consult the sky-map on page 90.) Now the tale of Atlantis expressly mentions (*Critias* 116E) an altar in the vicinity — presumably in front — of the temple of Poseidon, the temple in which the metal pillar stood. Upon this altar the flesh of the sacrificial bull was burned. What are we to make of this? Note that Ara is diametrically across from Canopus in the southern sky. It looks, therefore, as if we have in Ara and Canopus the celestial prototype of the altar and pillar mentioned in the myth. The myth of Atlantis also explains that, to get to and from the innermost island of Poseidon, a ship could pass beneath fortified bridges overarching the canal constructed by Atlas's descendants. This detail, too, has a celestial prototype: the poop of the Argo, northbound in the Milky Way. For the overarching bridges would conceal from view the center and bow portions of a ship that had begun a passage beneath such a bridge.

Yet if the entire section of the southern sky from the south pole to about latitude $-50°$ is to be equated with the central island of the Atlantis myth, then the concentric bands of water and earth with which Poseidon and his successors ring this island must be taken to represent celestial latitudes reaching at least as far as the central area of the sky, which we describe in terms of equator and ecliptic, the Babylonians as the way of Anu, and the early Egyptians as a belt of stars, led off by Sirius. Happily, that very supposition is entirely consistent with Plato's statement that on the second of the circular bands of land (counting outward from the central island) Atlas's descendants laid out an "equestrian race-track" flanked on either side by "barracks for the greater part of the spearmen." (*Critias* 117C). After all, the central area of the sky is the realm of the planets, and the association of the differential planetary revolutions with races and racetracks is standard throughout antiquity (being reported in connection even with the Roman Circus Maximus). Moreover, the central area of the sky is the realm of the constellations composing the zodiac. And those constellations

are normally pictured as "houses." Furthermore, other subdivisions of this central area of the sky, both temporal and spatial, are pictured as people or as "warriors."

If, then, the "sea" linked by canal to the central island represents the sky at large, the Galaxy represents that very canal, and the concentric bands represent circular areas of the sky, what does the enormous irrigated plain represent in celestial terms? (Recall that the rulers of Atlantis made an irrigated rectangle out of the arable portion of Atlantis island.) Pegasus Square leaps to mind as the most likely candidate. For the Babylonians regarded Pegasus Square as the primordial field; and they made it "leader" (in a Babylonian star catalogue of around B.C. 1100) of the stars in the way of Ea (roughly the lower third of the sky).

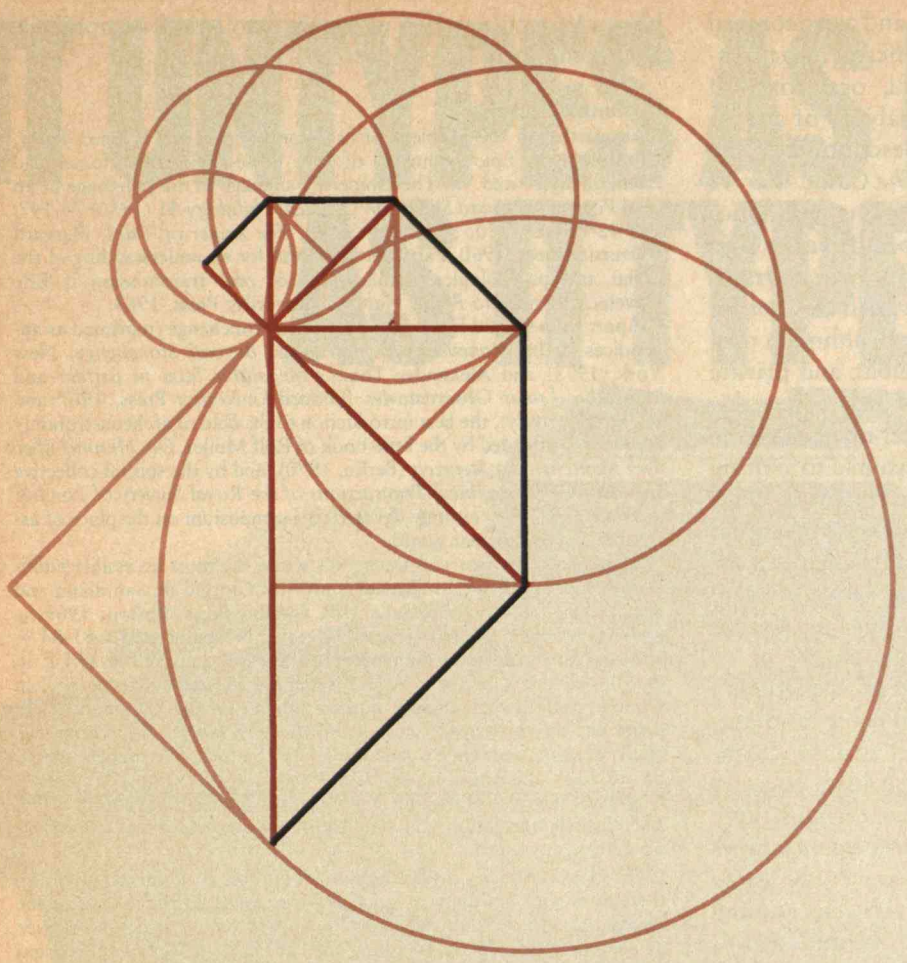
One final category of evidence ought now to be weighed: namely, what significance can we attribute to the numerical values embodied in the dimensions of the island-within-an-island designed by Poseidon?

The illustration on page 96 shows the proportions of Poseidon's island. One conclusion is especially striking: What Poseidon had instructed his successors to do, and what those successors had inscribed on a metal pillar, viz. "to give equal honor both to the even and the odd" (*Critias* 119C), Poseidon himself had done first; for the numbers 2 and 3, with their sum (5) and product (6), appear repeatedly in the construction. Consider that Poseidon's construction extends to the fifth band in the illustration, i.e. to the band with the outer diameter of 27 stades. (Poseidon's successors added the sixth band.) The original construction, designed by Poseidon, thus comprises six (i.e. 2×3) parts: a central island with a diameter of five (i.e. $2 + 3$) stades; and then five concentric bands, three of them destined to be filled with water and the remaining two, intercalated in between, to be annular bands of land. The three bands of water have an aggregate width of six (i.e. 2×3) stades; the two bands of land have an aggregate width of five (i.e. $2 + 3$). To top it off, the area of the outermost band of water is 216 square stades (i.e. $2^3 \times 3^3$). The reason for all this undoubtedly has to do with the Pythagorean-Platonic practice of classifying certain numbers by means of a colorful symbolic shorthand sometimes misconstrued as "number mysticism." In this system, two and all numbers divisible by two are termed "female" and all odd numbers (starting with three) are termed "male"; their sum (five) and product (six) are consequently spoken of as being "marriage" numbers. It seems, therefore, that much as a Renaissance prince might adorn the boudoir of his mistress with the motif of his and her initials intertwined, so does Poseidon, in Atlantis, surround his marriage bower (recall that he mated with a mortal woman on Atlantis) with the numerate equivalents of marriage.

But this is not all. Poseidon's choice of the central island's radius (2.5 stades) is such — and this appears to have gone unnoticed in the scholarly literature so far — that of the six radii defining the annular bands of earth and water, the second, fourth, and fifth are practically equal to the first, third, and fourth as multiplied by $\sqrt{2}$. The third radius is rather too large to be $\sqrt{2}$ times the second (5.5 instead of 5); but its excess is corrected by the corresponding shortfall of the sixth (13.5 instead of 14.8). Apparently, Plato had two constraints to meet — that of having Poseidon equally honor the even and the odd, and that, it seems, of creating the progression we are here considering. Thus it appears valid to note that each of the radii is greater than the preceding radius by a factor approaching $\sqrt{2}$; that is to say, the progression of radii can be expressed very nearly in the form $r_{n+1} = \sqrt{2}\ r_n$. Accordingly, if all six radii are graphed as at the right, it can readily be seen that each radius turns out to be the side of a square whose diagonal is the next larger radius. This is a point of considerable importance to the early Pythagorean mathematicians. For the Pythagoreans believed, as an extrapolation of data derived from music and astronomy, that progressions of integers (or musical intervals composed of integers) recurred throughout the universe: in the successive realms of number, figure, solid, vibrating string, and revolving planet. Doubtless, therefore, they were horrified to find, upon constructing a square of unit size, that the diagonal of that square has an irrational value, and thus is "incommensurable," to use their term, with the rational — indeed, integral — measure of the side. Doubtless, too, they were relieved to find that commensurability could be restored at the next higher dimension — that of plane geometry — by taking the diagonal of the square to be the side of a larger square. For the area of the larger square is once again commensurable — it has a rational value. In short, therefore, an apparent incommensurability at the level of arithmetic is reconciled at the level of plane geometry, and nothing has occurred to invalidate the Pythagorean axiom of universal, i.e. cosmos-wide commensurability.

In his old age Plato is known to have postulated the extension of this principle (of restoring commensurability by moving to successively higher dimensions) to include solid geometry and kinematics, both musical and astronomical (*Epinomis* 991D-992A). In the case at hand, Poseidon performs the transition from the first to the second dimension no less than six times in succession. The principle is important in view of "Poseidon's" manifest identity (see above) with the Engineering God Kronos/Saturn — the same, presumably, who in the *Timaeus* had functioned as engineer of the entire astronomical cosmos. In effect, Poseidon/Kronos is proclaiming, from his present "island" abode at or near the celestial south pole, that same universal commensurability which, in a previous, "Golden" world era, he had embodied in the astronomical universe at large. For we have already seen that the rings surrounding the central island of Atlantis can be understood as bands of the sky reaching all the way to the middle, equatorial-zodiacal realm.

Visually, the spiral we have generated at the right by connecting the successive radii of Poseidon's central island resembles a marine conch-shell. This is a happy circumstance, for both generally and specifically, the conch is ideally suited to serve as Poseidon's personal emblem. It is generally suitable because the conch is traditionally blown by members of Poseidon's marine entourage in the



"Poseidon's conch": a geometrical construction made by the author to demonstrate a possible significance in the radii chosen by Poseidon for the concentric bands of earth and water with which he ringed his sanctuary on Atlantis. In the construction, each of the six lines shown in dark brown is first made the side of a square, and then the diagonal of a larger square. The sequence of lines, if one begins with 2.5, turns out to be 2.5, 3.5, 5.0, 7.0, 9.9, and 14.0. These are close to the values for the radii of Poseidon's island as shown on page 96. (If one multiplies each of Poseidon's radii by $\sqrt{2}$ and compares the result with the value of the next larger radius, the fit is even closer.) For the significance of converting the side of a square to the diagonal of a larger square, consult the text. The outer sides of the consecutive squares are shown here in black. Note that they form the stylized outline of a conch-shell — an appropriate symbol for Poseidon, who dwelt in the sea and whose entourage included Capricorn, blower of the conch-shell to halt the Deucalian flood.

briny deep, which in this case is the area near the celestial south pole to which, like the departed souls, one descends by way of a portal at the southernmost point of the zodiac. Specifically it is suitable because the conch was reportedly invented by Capricorn, the watery figure associated with winter solstice at the southernmost point of the zodiac. The blowing of the conch-shell by Capricorn, incidentally, signalled the end of the Deucalian flood. Have we, then, come upon the tell-tale symbol of "Poseidon's" power over the "waters of the deep" which engulfed Atlantis? After all, the power to generate earthquakes and tidal waves is traditionally his rather than Zeus's. Consider, too, the directives issued by Poseidon to his ten sons and inscribed by them on a metal pillar, yet evidently disregarded by his remote descendants at the stage of their corruption. Consider, in particular, that the oath taken by Poseidon's sons invoked "mighty curses upon them that disobeyed" (*Critias* 119E). It is obvious from the width of the land-belt added by Poseidon's descendants (50 stades) that the "law" of Poseidon's conch has been broken. What should have been a radius of 19 stades turns out to be 63.5 stades — more than three times larger.

This article has offered, in briefest outline form, the case for considering the layout of Plato's Atlantis as an embellished version of what in original intention was a map of the sky — and not a memory of lost islands or continents. There remains, however, a rather general question that may trouble contemporary readers: If our account, or something like it, is indeed the underlying meaning of Plato's myth of Atlantis, why did not Plato state that meaning plainly and overtly? Why should he have chosen to mystify us (if that is the right term) both as to the ultimate referent and as to the logic informing his own numerical elaboration of the myth?

The answer is surely that Plato was heir to the ancient and widespread conviction that the sky is the place of the (astral) deities and at once the origin and ultimate destiny of our souls. Astronomical knowledge is therefore at once scientific and sacred. Indeed, the very act of formulating the numbers and figures that govern the behavior of astronomical bodies is a method by which to enhance our intellectual and moral qualifications for posthumous reassimilation to the starry realm from which we came. Thus, the inherent difficulty of astronomical observation, modelling, and computation combines with the belief in the moral import of this purely "theoretic" activity, and out of this fusion comes a style of scientific communication verging on the esoteric. Plato's motive, then, is not the (to us) familiar one of safeguarding one's intellectual property prior to (or in the absence of) patents and copyrights. Rather, it is a quasi-religious respect for the dignity and importance of the subject-matter. The proper format for handing it on is not indiscriminate (i.e. written) dissemination but oral instruction of intellectually and morally qualified pupils only.

Surely this explains the prolonged resistance by the an-

cients to the translation of cosmological and astronomical information into written form, and specifically into mathematical notation. That the traditional, oral form of transmission was not due to the unavailability of a written alternative is shown by Caesar's description of the priestly discipline as practiced in Gaul (*The Gallic War* VI 14): "It is said [reports Caesar] that the young apprentice priests have to memorize a large number of verses and that some of them spend as long as twenty years in training. And they [the Druids] *think it irreverent to commit these verses to writing* [the italics are ours], although they use Greek letters for almost all other public and private affairs." Somewhat superficially, Caesar first traces this belief to a mere penchant for secrecy. Later on, though, he ascribes it more justly to the fear lest recourse to writing dull the powers of memory. Just so in the *Phaedrus,* Plato has the Eyptian god Amon object to Mercury's invention of writing on the grounds that it will weaken men's memory and foster the illusion that the dead letter of mere memory-aids can produce a knowledge equivalent to that born only from living exchange with a master.

Caesar then continues: "A central tenet of [the Druids'] teaching is the immortality and posthumous transmigration of souls, a doctrine calculated to inspire death-defying courage. To this end they discourse on, and transmit to the young, many matters concerning stars, constellations, and planets [the Latin term *sidera* covers all three], including their motions, the size of the earth and its several regions, the nature of the universe, and the power and influence of the imperishable [because astral] deities."

By using metaphorical and mythological language, the priestly experts in charge of archaic astronomy managed to reconcile two ostensibly conflicting responsibilities: that of acting as society's encyclopedic memory and mouthpiece and that of transmitting the astronomical portion of this information in a form consistent with its sacred character. Notice that neither of these priestly roles compelled the experts to imagine that their myths embodied the entire "truth." On the contrary (to judge by Homer, Plato, and others), it seems to have been generally affirmed among the ancients that the intrinsic nature of the gods eludes mortal man. Doubtless, therefore, it was understood — at least by the experts — that a myth (or even a numerical law) would provide only limited insights. That is to say, it would express only the outward, observable behavior of celestial objects. But it would be of little help in plumbing the Reasons for both human and cosmic destiny. In much the same way does the unknown x of an algebraic equation serve to express the relations into which x enters, without specifying the "true" nature of x itself.

All of this suggests that the ancient myth-makers may have thought of their stories as purely tentative and imaginative, i.e. as but the pseudo-historical, pseudo-geographic, and pseudo-zoological guises of deities unknowable in themselves. The myths, on that reading, reveal themselves as ways by which the ancients defined cognitive limits: the limits within which (to adapt Gibbon's description of the Nicene Creed) the almost invisible and tremulous ball of man's theological comprehension could be allowed securely to vibrate.

For further reading:

Basic works on the problem of oral composition are Milman Parry, "Studies in the Epic Technique of Oral Verse-Making: I. Homer and Homeric Style" and "II. The Homeric Language as the Language of an Oral Poetry," *Harvard Studies in Classical Philology* **41** (1930) 73-147, and **42** (1932) 1-50; and Albert Lord, *The Singer of Tales,* Harvard University Press, 1960. Particularly helpful for an understanding of the social and psychological implications of oral transmission is Eric Havelock, *Preface to Plato,* Harvard University Press, 1963.

Apart from Gerald Hawkins's papers on Stonehenge (reprinted as appendices to his *Stonehenge Decoded* and *Beyond Stonehenge,* New York, 1973) and Alexander Thom's *Megalithic Sites in Britain* and *Megalithic Lunar Observatories* (Oxford University Press, 1967 and 1971 respectively), the best introduction to the field of archeoastronomy is probably afforded by the little book of Rolf Müller, *Der Himmel über dem Menschen der Steinzeit* (Berlin, 1970), and by the special collective issue of the *Philosophical Transactions of the Royal Society of London* (volume 276, 1974) entirely devoted to a symposium on the place of astronomy in the ancient world.

Regarding Professor von Dechend's work, the most accessible publications to English-speaking readers are still Giorgio de Santillana and Hertha von Dechend, *Hamlet's Mill,* Gambit Press, Boston, 1969 — with my review in *Classical Journal,* October/November 1973, 81-83 — and two large folders of mimeographed lectures delivered at M.I.T. in the 'sixties in the course of several seminars on archaic cosmology. In German there is a great deal more: a chapter on the "Donnerkeil" in *Prismata: Naturwissenschaftsgeschichtliche Studien. Festschrift für Willy Hartner,* edited by Maeyama and Saltzer (Wiesbaden, 1977, pp. 95-118), and fifteen typed, bound volumes, averaging 120 pages in length, of her Frankfurt University lectures and seminars since 1970. The English translation and publication of this important research is now being envisaged.

On Plato's Atlantis myth, there is, of course, an immense literature that starts with antiquity. A good first survey up to the middle of the nineteenth century is afforded by Thomas Martin's *Etudes sur le Timée de Platon,* Paris, 1841, volume I, pp. 257-333, and, for subsequent years, by Hans Herter, "Platons Atlantis," *Bonner Jahrbücher,* 133 (1928) 28-47, and by Jean Bidez, *Eos ou Platon et l'Orient,* Brussels, 1945, pp. 19-40. Advocacy of the Santorin hypothesis of Marinatos and Galanopoulos can be found in Mavor, *Voyage to Atlantis,* New York, 1969.

For Egyptian and Babylonian astronomy, consult G. van der Waerden, *Science Awakening,* volume II, *The Birth of Astronomy,* New York, 1974, and for Egyptian celestial geography, consult Daressy, "L'Egypte Céleste," *Bulletin de l'Institut Français d'Archéologie Orientale du Caire,* XII (1915) 1-34.

For circular and spherical models in Greek astronomy, consult Dreyer, *A History of Astronomy from Thales to Kepler,* New York, 1953, pp. 53-122, and Walter Saltzer, *Theorien und Ansätze in der Griechischen Astronomie,* Collection des Travaux de l'Académie Internationale d'Histoire des Sciences No. 23, (Wiesbaden, 1976) p. 65.

For the archaic character of the rituals performed in Atlantis, see Hans Herter, "Das Königsritual der Atlantis," *Rheinisches Museum* **109** (1966) 236-59.

Finally, for the numbers incorporated by Poseidon into Atlantis, see the important exchange between Brumbaugh, "Note on the Numbers in Plato's *Critias,*" *Classical Philology* **43** (1948) 40-42, and Rosenmeyer, "The Numbers in Plato's *Critias:* A Reply," *Classical Philology* **44** (1949) 117-20. My own analysis is in preparation.

Needless to say, the preceeding references do not pretend to be exhaustive. They are merely meant to point interested readers in the direction of further readings on certain key topics.

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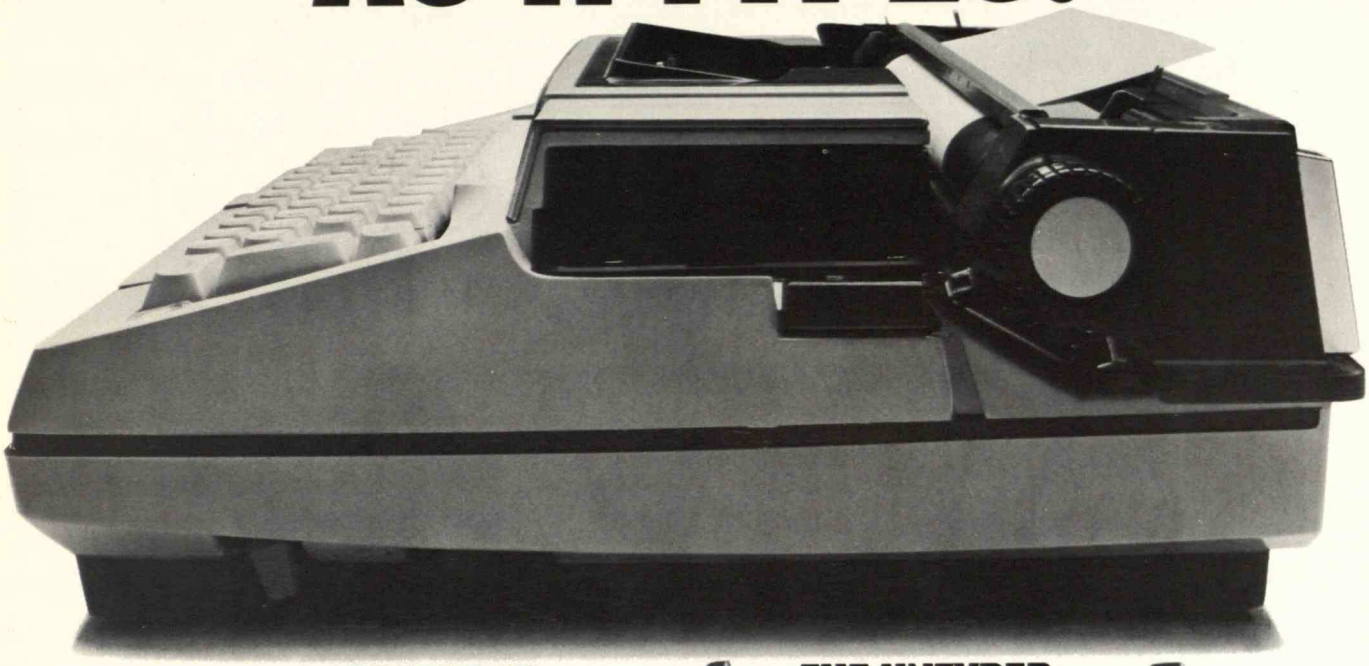

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